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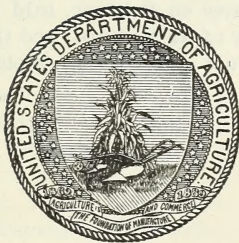


# ANNUAL REPORTS OF THE DEPARTMENT OF AGRICULTURE

FOR THE YEAR  
ENDED JUNE 30

1920

REPORT OF THE  
SECRETARY OF AGRICULTURE  
REPORTS OF CHIEFS



WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1921

ANNUAL REPORT OF  
THE DEPARTMENT OF  
AGRICULTURE

[CHAPTER 23, Stat. L., 1895.]

[AN ACT Providing for the public printing and binding and the distribution of public documents.]

\* \* \* \* \*

Section 73, paragraph 2:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part One, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; Part Two, which shall contain such reports from the different Bureaus and Divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of Part One, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of Part Two, one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture; and the title of each of the said parts shall be such as to show that such part is complete in itself.



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REPORT OF THE  
SECRETARY OF AGRICULTURE.

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## REPORT OF THE SECRETARY OF AGRICULTURE.

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WASHINGTON, D. C., *November 15, 1920.*

SIR: The farmers of America have again justified the faith of the Nation in their ability to meet its requirements of food, feed, and raw materials for clothing. They have produced this year, in the face of enormous difficulties, the largest harvest in the history of American agriculture, with a single exception. The combined yield of the 10 principal crops is 13 per cent above the average for the five years preceding the outbreak of the World War.

The corn crop of 3,199,000,000 bushels is unprecedented, representing more than four-fifths of the world's production. The sweet potato crop of 106,000,000 bushels is the largest ever produced and far in excess of that of any other year except 1919. The rice crop of 52,000,000 bushels is one-fourth greater than the largest crop ever before harvested. The tobacco crop of 1,476,000,000 pounds considerably exceeds any previous yield. The sugar-beet crop is more than one-third larger than the largest ever before recorded. The grain sorghum crop of 149,000,000 bushels is 18 per cent above that of 1919, which was itself a record crop. The potato crop of 421,000,000 bushels has been exceeded only once, and then by a very narrow margin. The oat crop of 1,444,000,000 bushels has been exceeded only three times, and the tame hay crop of 88,000,000 tons only twice. The apple crop of 236,000,000 bushels has been exceeded only once, in 1914. The yields of wheat, barley, buckwheat, peaches, peanuts, edible dried beans, flaxseed, and cotton are slightly below the average, but they, nevertheless, represent an enormous volume in the aggregate. The number of all classes of live stock on farms, although less than the number in 1919, exceeds by 18,214,000 the average for the five years preceding the outbreak of the European war.

### **MANY OBSTACLES ENCOUNTERED.**

These remarkable results were achieved under conditions which were decidedly disheartening at planting time. The farmers were confronted with an unusual number of obstacles, and many of them were formidable. The spring was late and cold and wet, threatening to restrict the crop acreage and making it uncertain whether seed would rot in the ground or whether those which germinated would

reach maturity. In only 4 years of the last 37 was the progress of plowing, up to May 1, so backward as in 1920. With this initial handicap and with the prevailing uncertainty regarding weather conditions during the growing season, the farmers were discouraged. They saw no hope of a reduction in the prices of fertilizers, machinery, and supplies, which had increased greatly since 1914. In addition, the labor supply was approximately 37 per cent short, and wages had risen to such a point in 1919 that the farmers were appalled at the thought of paying still higher wages in 1920. Many of the men who entered the military and naval services and war industries did not return to farm work. Wages in all industries, in trade and in transportation, increased so rapidly that their lure became irresistible to many laborers who had thus far remained on the farm, and they, too, were carried with the current to urban centers. Altogether, in the spring of 1920 the American farmers were confronted with the most difficult situation they had ever experienced.

The accompanying tables show at a glance the results of the year's agricultural operations, so far as the statistics are available, and indicate also the extent to which farm products have entered into our foreign trade.



*Acres of crops in the United States.*

[Figures refer to planted acreage for winter wheat and rye.]

Crop.	1920 (unrevised estimate, October, 1920).	1919 (subject to revision). <sup>1</sup>	1918	1917	1916	1915	1914	Annual average, 1910-1914.
<b>CEREALS.</b>								
Corn.....	103,648,000	102,075,000	104,467,000	116,730,000	105,296,000	106,197,000	103,435,000	105,210,000
Wheat.....	53,652,000	73,827,000	64,352,000	58,366,000	56,810,000	62,042,000	54,661,000	52,452,000
Oats.....	41,032,000	42,400,000	44,349,000	43,553,000	41,527,000	40,996,000	38,442,000	38,014,000
Barley.....	7,437,000	7,420,000	9,740,000	8,933,000	7,757,000	7,148,000	7,565,000	7,593,000
Rye.....	5,470,000	7,232,000	6,708,000	4,480,000	3,474,000	3,153,000	2,773,000	2,562,000
Buckwheat.....	752,000	790,000	1,027,000	924,000	828,000	769,000	792,000	826,000
Rice.....	1,345,000	1,089,800	1,118,550	980,900	869,000	802,000	693,000	733,000
Grain sorghums.....	5,342,000	4,893,000	6,036,000	5,153,000	3,944,000	4,153,000	.....	.....
Total.....	218,678,000	239,726,800	237,797,550	239,119,900	220,505,000	225,260,000	208,361,000	207,420,000
<b>VEGETABLES.</b>								
Potatoes.....	3,849,000	4,013,000	4,285,000	4,384,000	3,555,000	3,734,000	3,711,000	3,686,000
Sweet potatoes.....	1,022,000	1,029,000	940,000	919,000	774,000	731,000	603,000	611,000
Total.....	4,871,000	5,042,000	5,235,000	5,303,000	4,329,000	4,465,000	4,314,000	4,297,000
Tobacco.....	1,859,700	1,901,200	1,647,100	1,518,000	1,413,000	1,369,900	1,224,000	1,209,000
Cotton.....	35,504,000	33,344,000	36,008,000	33,841,000	34,985,000	31,412,000	36,832,000	35,330,000
Grand total.....	260,912,700	280,014,000	280,687,650	279,781,900	261,242,000	262,506,900	250,731,000	248,256,000

<sup>1</sup> Figures for 1919 are to be revised Dec. 14, 1920.<sup>2</sup> Excluding grain sorghums.

*Crop production in the United States.*

[The figures are in round thousands—i. e., 000 omitted.]

Crop.	1920 (unrevised estimate, November, 1920).	1919 (subject to revision).	1918	1917	1916	1915	1914	Annual average, 1910-1914.
<b>CEREALS.</b>								
Corn.....	3,199,126	2,917,450	2,502,665	3,005,233	2,566,927	2,994,793	2,672,804	2,732,457
Wheat.....	750,648	940,987	921,438	636,655	636,318	1,025,801	891,017	728,225
Oats.....	1,444,411	1,248,310	1,538,124	1,592,740	1,251,837	1,549,030	1,141,060	1,157,961
Barley.....	191,386	165,719	256,225	211,759	182,309	228,851	194,653	186,208
Rye.....	77,893	88,478	91,041	62,933	48,862	54,050	42,779	37,568
Buckwheat.....	14,321	16,301	16,905	16,022	11,662	15,056	16,881	17,022
Rice.....	52,298	41,059	38,606	34,739	40,861	28,947	23,649	24,378
Grain sorghums.....	148,747	126,058	73,241	61,409	53,858	114,460	.....	.....
<b>Total.....</b>	<b>5,878,830</b>	<b>5,544,362</b>	<b>5,438,245</b>	<b>5,631,490</b>	<b>4,792,634</b>	<b>6,010,988</b>	<b>4,983,143</b>	<b>4,883,819</b>
<b>VEGETABLES.</b>								
Potatoes.....	421,252	357,901	411,860	442,108	286,953	359,721	409,921	360,772
Sweet potatoes.....	105,676	103,579	87,924	83,822	70,955	75,639	56,574	57,117
Beans (commercial).....	9,364	11,488	17,397	16,045	10,715	10,321	11,585	.....
Onions (commercial).....	15,132	9,412	19,336	12,376	8,562	7,664	( <sup>2</sup> )	.....
Cabbage (commercial).....	622	289	498	475	255	671	( <sup>2</sup> )	.....
<b>FRUITS.</b>								
Peaches.....	44,523	50,434	34,133	45,066	37,505	64,097	54,109	43,752
Pears.....	15,558	13,902	12,993	13,281	11,874	11,216	12,086	11,184
Apples.....	236,187	147,457	169,911	163,117	204,582	76,670	253,200	197,898
Cranberries (3 States).....	432	641	352	249	471	441	697	.....
<b>MISCELLANEOUS.</b>								
Flaxseed.....	10,736	8,919	13,369	9,164	14,296	14,030	13,749	18,353
Sugar beets.....	8,812	6,421	5,949	5,980	6,228	6,511	5,585	5,391



Tobacco.....	1,476,444	1,389,458	1,439,071	1,249,276	1,153,278	1,062,237	1,034,679	991,958
All hay.....	106,451	108,666	91,139	98,439	110,992	107,263	88,686	81,640
Cotton.....	12,123	11,330	12,041	11,302	11,450	11,192	16,135	14,259
Sorghum sirup.....	37,402	33,312	33,387	37,472	13,668	14,823	13,551	.....
Peanuts.....	37,499	33,263	46,010	52,505	34,434	.....	.....	.....
Broom corn (5 States).....	37	53	58	57	39	52	.....	.....
Clover seed.....	1,593	1,099	1,102	1,488	1,706	.....	.....	.....

† Excludes grain sorghums.

‡ No estimate.

*Estimated production of meat and wool.*

[The figures are in round thousands, i. e., 000 omitted.]

Product.	1920	1919	1918	1917	1916	1914	1909
Beef <sup>1</sup> .....pounds..	7,000,000	7,422,000	8,465,000	7,384,007	6,670,938	6,078,908	8,133,000
Pork <sup>1</sup> .....do....	9,000,000	11,388,000	11,248,000	8,450,148	10,587,765	8,768,532	8,199,000
Mutton and goat <sup>1</sup> ..do....	600,000	635,000	537,000	491,205	633,969	739,401	615,000
Total.....do....	16,600,000	19,445,000	20,250,000	16,325,360	17,892,672	15,586,841	16,952,000
Wool (including pulled wool).....pounds..	307,366	313,160	298 870	281,892	288,490	290,192	289,420

<sup>1</sup> Estimated for 1914-1919 by the Bureau of Animal Industry. Figures for meat production for 1920 are tentative estimates based upon 1919 production and a comparison of slaughter under Federal inspection for 7 months of 1920 with the corresponding 7 months in 1919.

*Number of live stock on farms on Jan. 1, 1910-1920.*

[The figures are in round thousands, i. e., 000 omitted.]

Kind.	1920	1919	1918	1917	1916	1915	1914	Annual average, 1910-1914.
	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>
Horses.....	21,109	21,482	21,555	21,210	21,159	21,195	20,962	20,430
Mules.....	4,995	4,954	4,873	4,723	4,593	4,479	4,449	4,346
Milk cows.....	23,747	23,475	23,310	22,894	22,108	21,262	20,737	20,676
Other cattle.....	44,485	45,085	44,112	41,689	39,812	37,067	35,855	38,000
All cattle.....	68,232	68,560	67,422	64,583	61,920	58,329	56,692	58,676
Sheep.....	48,615	48,866	48,603	47,616	48,625	49,956	49,719	51,929
Swine.....	72,909	74,584	70,978	67,503	67,766	64,618	58,933	61,865

*Exports of domestic foodstuffs and cotton from the United States.*

Reports of Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

Article exported.	Year ending June 30—						Annual average, 1910-1914.	Three months' average, July-September, 1920.	
	1920		1919	1918	1917	1916			1915
	Amount.	Per cent of 1910-1914.							
Wheat.....bushels...	122,430,724	215.1	178,582,673	34,118,853	149,831,427	173,274,015	259,642,533	56,913,228	82,178,319
Wheat flour.....barrels...	21,651,261	292.8	24,181,979	21,879,951	11,942,778	15,520,669	16,182,765	10,678,635	4,449,059
Oats.....bushels...	33,944,740	408.8	96,360,974	105,837,309	88,944,401	95,918,884	96,809,551	8,304,203	1,978,174
Rye.....do....	37,453,285	4,382.9	27,540,188	11,990,123	13,260,015	14,532,437	12,544,888	854,765	15,141,841
Barley.....do....	26,671,284	337.8	20,457,781	26,285,378	16,381,077	27,473,160	26,754,522	7,895,521	5,455,003
Corn.....do....	14,446,559	36.3	16,687,558	40,997,827	64,720,842	38,217,012	48,786,291	39,809,690	2,967,236
Total, 5 cereals and flour, pounds...	16,862,895,172	200.0	21,996,905,576	13,951,418,808	19,330,110,628	20,780,577,136	26,567,042,632	8,429,735,124	7,141,988,840
Sugar.....do....	1,444,030,665	2,034.5	1,115,865,161	576,483,050	1,248,908,286	1,630,150,863	549,007,411	70,976,908	86,968,547
Dairy products:									
Butter.....do....	27,155,834	642.3	33,739,960	17,735,966	26,835,092	13,487,481	9,850,704	4,277,955	1,340,588
Cheese.....do....	19,387,158	394.2	18,791,553	44,303,076	66,050,013	44,394,301	55,362,917	4,915,502	1,287,329
Milk (condensed).....do....	710,533,270	4,504.5	728,740,509	528,759,232	259,141,231	159,577,620	37,235,627	15,773,900	74,782,516
Total dairy products.....do....	757,067,262	3,032.2	781,272,022	590,798,274	352,026,336	217,459,402	102,449,248	24,967,357	77,410,433
Meat and meat products:									
Canned beef.....do....	31,166,814	331.8	108,459,660	97,343,283	67,536,125	50,803,765	75,243,261	9,392,122	6,693,169
Fresh beef.....do....	153,560,647	521.4	332,205,176	370,032,900	197,177,101	231,214,000	170,440,934	29,452,302	7,814,707
Pickled beef.....do....	32,383,501	98.5	45,065,641	54,467,910	58,053,667	38,114,682	31,874,743	32,893,172	5,739,643
Oleo oil.....do....	74,529,394	26.6	59,292,122	56,603,388	67,110,111	102,645,914	80,481,946	280,224,505	13,313,514
Oleomargarine.....do....	20,952,180	641.1	18,570,400	6,309,896	5,651,267	5,436,221	5,252,183	3,268,279	1,491,657
Stearin.....do....	22,505,602	695.8	11,537,284	10,360,030	12,936,357	13,062,247	11,457,907	13,234,533	2,908,665





*Exports of live stock from the United States.*

[Bureau of Foreign and Domestic Commerce, United States Department of Commerce.]

Kind.	1920	1919	1918	1917	1916	1915	Annual average, 1910-1914.	3 months, July-September, 1920.
	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>
Horses.....	18,952	27,975	84,765	278,674	357,553	289,340	28,073	3,870
Mules.....	8,991	12,452	28,879	136,689	111,915	65,788	5,125	1,309
Cattle.....	93,039	42,345	18,213	13,387	21,287	5,484	88,225	16,718
Sheep.....	59,155	16,117	7,959	58,811	231,535	182,278	522,505	4,543
Swine.....	36,107	17,390	9,280	21,926	22,048	7,799	11,191	13,662

**CONFRONTED WITH FALLING MARKET.**

After the farmers had completed their planting and harvesting operations, after they had met and solved the problems of production, they found themselves face to face with a **falling market**. As a result, a situation has been brought about which may have serious consequences, immediate and remote, to our agriculture and to the Nation.

During all the months when the farmers were cultivating their crops, paying for labor and supplies at unusually high rates, the prices of agricultural commodities generally remained high. In midsummer, when the farmers' period of outlay was nearly at an end and their income period was about to begin, a sharp decline occurred in the prices of practically all farm products. Covering nearly everything the farmers had to sell, it did not materially affect the articles they had to buy. For labor and materials used in harvesting they were compelled to pay prices substantially as high as those prevailing during planting and cultivation.

**SHRINKAGE OF VALUES.**

The year's output, produced at an abnormally high cost, is worth, at current prices, \$3,000,000,000 less than the smaller crop of 1919 and \$1,000,000,000 less than the still smaller crop of 1918. In other words, it is estimated that the total farm value of all crops produced in 1920 is \$13,300,000,000, compared with \$16,000,000,000 in 1919, \$14,300,000,000 in 1918, and \$13,500,000,000 in 1917. Live stock and its products also declined to such an extent as to cause serious losses to producers. The best estimate that can now be made indicates that the total value of animal products in 1920 is \$8,757,000,000, or about \$200,000,000 less than in 1919. There is probably no other industry or business that could suffer a similar experience and avoid insolvency.

## RELATIVE PRICES OF ALL CROPS.

It is interesting, in this connection, to note the relative prices during the year of all crops grown in the United States. On March 1 they were 22 per cent *higher* than on the same date last year; on April 1, 23 per cent; on May 1, 23 per cent; on June 1, 24 per cent; on July 1, 21 per cent; on August 1, they were the same as on August 1 a year ago; on September 1, they were 7 per cent *lower* than a year ago; on October 1, 14 per cent *lower*; and on November 1, 28 per cent *lower*. The prices of all crops on November 1 were 33 per cent below those prevailing when the farmer planted and bore the cost of production.

The situation may be presented in another way, using corn, cotton, and wool as examples. The corn crop totals 3,199,000,000 bushels. At November 1 prices the farmers would receive for it approximately \$1,500,000,000 less than what it would bring on the basis of prices prevailing in November a year ago. The cotton crop aggregates 12,123,000 bales. At existing prices it would lack more than \$1,000,000,000 of bringing as much as it would have brought at 1919 prices. The wool clip, including pulled wool, amounts to 307,366,000 pounds. At prices prevailing in October, 1919, it would have brought \$153,683,000, but this year, on the basis of current prices, it would bring \$84,525,650, a reduction of about \$69,000,000.

This means that the farmers of the United States, as a whole, are not receiving adequate returns for their efforts. It means also that the very foundation of our Nation—the stability of our agriculture—is threatened, and that everything possible must be done to prevent, or at least to lessen the effect of, the recurrence of conditions under which large numbers of farmers conduct their operations at a loss. The farmer must have, under ordinary conditions, a reasonable prospect of a fair return for his labor and the use of his capital. The science, the art, and the business of agriculture can not thrive unless he is suitably and profitably paid for the products of his farm—unless he receives compensation sufficient to enable him to continue to produce and to maintain for himself and his family satisfactory standards of living.

## NO SINGLE SOLUTION FOR SITUATION.

A sober national thought with regard to the importance, the absolute necessity, of a sustained agriculture in this country is imperative. There is, perhaps, no single solution for the situation which the farmers are now facing, but there are many steps which can and should be taken to place our agriculture on a more satisfactory basis and to stabilize the business of farming, not in the interest of the farmers alone but in the interest of the Nation as a whole. The



matter is of such tremendous importance to our entire population that it should be recognized everywhere as a national problem and dealt with as such.

We must adopt every feasible means to enable the farmer to adjust himself to changes in economic conditions such as have recently occurred. It ought to be a fact that, when the farms of the country produce abundantly, the consuming public will be liberally supplied with food at reasonable prices, the farmer taking his profit because of large production and the consumer receiving his increment of benefit from having available an adequate supply at a reasonable cost. In general, we should expect it to be true that the farmer's condition is improved in direct proportion to the number of bushels of wheat or corn or the number of bales of cotton he produces. It frequently happens, however, that, when all farmers have extraordinarily good crops during the same year, low prices leave him worse off than he has been in other years with short crops and high prices. One thing that would help to remedy this is some means of carrying over to periods of low production, wherever feasible, the surplus from years of high production. More attention to marketing and the development of the latent consumption demand in years of large supply also would be helpful.

#### STUDY OF WORLD CONDITIONS.

The Department of Agriculture has been fully alive to the existing situation and has been keeping in close touch with market conditions, ready at all times to render any feasible aid in reducing the losses suffered by farmers on account of the price declines. The drop in the price of wheat was especially sharp and it was charged, in many quarters, that this was due to manipulation, control, or other artificial causes, as well as to the importation of Canadian wheat into this country. You, Mr. President, therefore, asked the Federal Trade Commission immediately to ascertain whether there was any basis for this charge, and I understand that the commission is actively at work on the problem. At the same time, you requested the Department of Agriculture to obtain all available information regarding the world supply of and demand for wheat, including the importation of Canadian wheat and its probable effect on the domestic market, and the department has proceeded vigorously with this task. Recognizing, also, that the depressed market situation was due, in part at least, to conditions following the World War and to the lack of buying power and decreased consumption in European countries, a committee was appointed in the department to canvass the entire agricultural situation with the view of collecting all available data having any bearing upon it. These data will enable us to see more clearly the problems that lie ahead of us. As soon as the material can be brought

together and put in satisfactory shape, it will be published in order that farmers may be in position to determine what the trend in the future is likely to be and what they may do to adjust their operations next spring to world conditions. In this work, the department has had the cooperation of a committee representing the agricultural colleges and experiment stations and also of representatives of farmers' organizations.

#### **MARKETING WORK SHOULD BE EXPANDED.**

We must see to it that the road between the producer and the consumer is open and direct and that the farmers have a free and competitive market in which to dispose of their products. We must omit no effort to improve our marketing machinery and practices and to furnish necessary market information to the farmer so that he may take full advantage of modern business methods in the distribution of his commodities. The Bureau of Markets, created in 1913, is devoting its attention to the solution of the many complex problems arising in connection with the marketing of farm products. It is dealing, first of all, with several fundamental steps which are essential to constructive work in this great undeveloped field. These include particularly the accumulation of fundamental data regarding marketing processes and costs; the dissemination of accurate, disinterested market information; the elimination, wherever practicable, of waste and unnecessary marketing expenses; the development of standards for the grading of farm products and the standardization of containers; the promotion of efficiency in the storing, handling, and shipping of farm products; and the regulation of marketing machinery in order to prevent any abuses or sharp practices that may exist. Work along these lines is being prosecuted as vigorously as possible with the available funds and facilities, and provision has been made in the estimates, to be submitted to the Congress at its next session, for its further development during the next fiscal year. If the necessary appropriation is granted, special emphasis will be placed upon studies relating to the costs of marketing and the systematic collection and dissemination of statistics regarding the production and supply of, and demand for, agricultural products in foreign countries.

#### **COSTS OF MARKETING.**

For some time it has been evident that reliable data regarding the costs of marketing should be gathered in order to supplement similar data concerning the costs of production. In fact, such data are essential to the correct understanding of our marketing processes and are fundamental to the development of plans for their improvement and the elimination of lost motion and unnecessary expenses. We should be able to indicate, with a fair degree of accuracy, the proportion of

the consumer's price received by the producer and the proportion received by various marketing agencies. Studies with reference to the cost of marketing live stock, grain, milk, and potatoes are now under way, and it is highly desirable that they be extended, as rapidly as possible, to include other staple agricultural commodities.

#### COOPERATIVE MARKETING.

The question of cooperation now occupies a prominent place in the public mind. High distributing costs have stimulated and increased the demand for greater efficiency in marketing. Producers everywhere are outspoken in their dissatisfaction with present marketing costs, which appear to exact an unduly large share of the price paid by the consumer. In their effort to reduce marketing expenses, producers are turning in many cases toward cooperative marketing. The distribution of farm products through cooperative organizations undoubtedly affords an opportunity for farmers to make more effective use of market information, to properly grade and market their products in commercial quantities, to find larger outlets, and to reduce costs and increase efficiency by shortening the channel between producers and consumers. In addition to more or less localized efforts, organizations of growers of wheat, cotton, and live stock have recently projected movements for the development of cooperative marketing on a broad scale.

The department recognizes fully the importance of the cooperative movement and its potentialities for good in the general marketing scheme, conducts investigations relating to its status and progress, and gives assistance to specific groups of producers who request help in the organization and operation of cooperative enterprises. This work should be extended and developed.

#### FOREIGN-MARKET INFORMATION.

Comparatively little systematic attention has been given to the development of foreign markets for farm products, or to obtaining and making available prompt, comprehensive, and dependable information with reference to the production, supply, and prices of, and demand for, agricultural commodities in the different parts of the world. While the Bureau of Markets has developed, to the extent permitted by available funds, a very efficient market-reporting service for the United States, no similar machinery for collecting and disseminating foreign-market information has been provided. The foreign markets division of the bureau is endeavoring to keep in close touch with conditions abroad, but it has neither the personnel nor the facilities for meeting the demands made upon it. It is highly essential that definite provision be made for the building up of this



branch of the department's work, in order that it may be in position to render effective service to producers, farm organizations, and others. Since May, 1918, an agricultural trade commissioner has been stationed in the United Kingdom to study the markets for agricultural products in Europe and to make timely reports for the information of American producers and exporters. The work of this commissioner has conclusively demonstrated the desirability of stationing additional commissioners at strategic points in the various markets of the world. Plans already have been developed for the establishment of an office in Buenos Aires to aid in promoting our trade with South America in pure-bred live stock.

The establishment of a world market-reporting service will not interfere in any way with the activities of the International Institute of Agriculture at Rome, but, on the contrary, will effectively supplement them. The reports issued by the institute are based largely on the official estimates of the various adhering Governments, but many of them are incomplete or are received too late to be of immediate practical service to producers and others in this country. They are, nevertheless, highly useful for historical and comparative purposes. The work of the institute was greatly interfered with during the war, but, following the meeting of the general assembly in Rome on November 3, it is anticipated that it will resume active operations. After the death of Mr. David Lubin, the delegate of the United States, this country was without representation at the institute for nearly two years. This was due to the fact that the amount allowed for salary and expenses, \$3,600 per annum, made it impossible to secure a man with the right sort of training and experience who would be willing to undertake the work permanently. At the suggestion of this department, the Secretary of State has recommended that the salary of the delegate be increased to \$7,500 per annum, and that provision be made for the payment of his traveling and miscellaneous expenses and for the employment of a secretary.

#### COMBINE MARKETING AND CROP-ESTIMATING WORK.

I have recommended in the estimates to the Congress that authority be given to consolidate the Bureau of Crop Estimates and the Bureau of Markets. I have been influenced to take this course by a number of important considerations. The first is that each of the bureaus, in accomplishing the important work with which it is charged, needs the additional strength that could be brought to it by some portion of the machinery of the other. In the second place, the legal duties of the two overlap in some directions, and there is a natural and inevitable tendency for each bureau to duplicate a portion of the other's work. This tendency would be eliminated by the proposed consolidation, and confusion in the public mind as to the

division of work between the two bureaus would be avoided. Furthermore, crop and market reports could be published together, and farmers and business men would have all the facts in one document. The leased telegraph wires of the Bureau of Markets could be utilized for transmitting crop information to Washington and for its prompt dissemination. In some States, the branch offices of the two bureaus could be brought together in the same quarters, and frequently the same crop and live-stock specialists could serve both bureaus, not only in this country but abroad. The operating forces of the two organizations could be combined, as well as the duplicating and mailing services and the staffs dealing with the purchase, custody, distribution, and utilization of supplies. Specialists working along statistical and economic lines in both bureaus could be brought together in a statistical research division to handle statistics of production, consumption, imports and exports, surpluses and deficiencies, and farm and market prices of agricultural products for all countries. In short, the proposed consolidation is in line with good administration and efficiency in the public service and should be put into effect without delay.

#### CROP AND LIVE-STOCK REPORTING SERVICE.

No problem can be satisfactorily considered, nor can any business be permanently successful, without accurate and complete statistics. Agriculture is the greatest business and the most fundamentally important industry in the United States, not only because of the amount of capital invested, the number of people employed, and the new wealth created annually, but because it supplies the Nation's food, furnishes vast quantities of raw materials for the manufacture of clothing and other necessary commodities, and contributes largely to the export trade of the country.

The Bureau of Crop Estimates, through more than half a century of experience, has developed and perfected methods for ascertaining and verifying many of the essential statistical facts of farm production. It is operating during the present fiscal year under the serious handicap of inadequate funds and reduced personnel, in the face of a constantly increasing demand for the services it is designed to render. Its appropriations were reduced by \$53,000 at the last session of the Congress, necessitating the discontinuance of the special reporting service for cotton, tobacco, rice, potatoes, truck, and fruit crops. Not only should this service be restored, but, as the demand for agricultural statistics, especially in connection with marketing problems, is steadily increasing, the time has come when an expansion of the machinery of the bureau is urgently needed. The data collected by the 1920 census will soon be available as bases for crop

and live-stock estimates during the next 10 years, and the expansion should be provided for without delay. The crop and live-stock reporting service should be greatly enlarged; farm surpluses should be ascertained periodically, and essential data should be published more promptly and in such form that they may be readily understood and utilized. Estimates of the funds required to enable the department to accomplish these purposes will be submitted to the Congress.

#### SUPERVISION OF LIVE-STOCK MARKETS.

The supervision of the live-stock markets, authorized by the President's proclamations of June 18 and September 6, 1918, issued under the provisions of the food-control act of August 10, 1917, has been continued by the Bureau of Markets, but the work has been greatly handicapped by the lack of funds. Definite proof was obtained that certain firms were exacting overcharges in the feed accounts of their shippers, and they were given an opportunity to refund the overcharges. Some did so, but six of them sought and obtained from the district court at Chicago an order restraining the Secretary of Agriculture from revoking their licenses. These cases are still pending, and further action on all similar cases involving such overcharges is necessarily deferred, awaiting the decision of the court.

In July and August, 1920, commission men in Chicago, Kansas City, Omaha, and East St. Louis put into effect new schedules of commission rates, providing increases ranging as high as 25 per cent on cattle, calves, hogs, sheep, and goats shipped in car lots by single owners. After careful consideration of the evidence and data in the possession of the department, the conclusion was reached that these increased rates were unjust and not warranted by trade conditions. Orders were issued, therefore, to all commission men in the cities named to refrain from exacting the increased rates or charges. They not only did not comply with the orders, but some of them instituted suits in the Federal courts to restrain the department and the United States attorneys from proceeding against them for failure to do so. Temporary restraining orders were granted by the courts and dates were set for the Government to be heard. At the hearings in Chicago and Kansas City, the department cooperated with the United States attorney in the argument of the legal questions involved, and the whole matter is now before the courts for determination. At Kansas City, under an order of the court, the commission men are depositing with the clerk of the court, to abide the results of the litigation, all receipts by them which represent the difference between the commissions they were ordered to discontinue and those found to be just and reasonable. A similar practice is being followed at Omaha and East St. Louis.



Another order was issued by the department in August, 1920, declaring the rates charged by the commission men at Chicago, Kansas City, Omaha, and East St. Louis for handling car lots having more than one owner to be unjust, unreasonable, discriminatory, and unfair, and substituting a different and equitable schedule of rates. This action was taken on the basis of information in the possession of the department and after a hearing held in Chicago on April 12 and 13, 1920, at which seven commission firms operating under Federal licenses appeared. The order of the department was complied with at Chicago and the lower rates made effective there, but it is being contested at the other points in conjunction with the suits involving the rates for single-owner shipments.

#### FARM MANAGEMENT AND FARM ECONOMICS.

The economic problems of agricultural production have long been uppermost in the minds of American farmers. They are pressing for solution and their importance has been sharply emphasized by the recent price declines. In spite of many handicaps, the Office of Farm Management and Farm Economics is dealing actively with these problems, giving special attention to matters relating to cost of production and farm organization, farm labor, farm finance, land economics, including land settlement and colonization, and the social side of rural life. Following the reorganization of the office in 1919, there was submitted to the Congress a revised estimate calling for additional funds for the development of its activities along the lines recommended by the committee on reorganization. The Congress, however, did not take favorable action on the proposal and no increase was granted. The recommendation was renewed in the estimates of the department for the fiscal year 1921, but the Congress again failed to provide the amount suggested, although it did grant a small increase over the appropriation for the fiscal year 1920.

In the estimates for the next fiscal year, I am recommending that an adequate sum be made available to the Office of Farm Management and Farm Economics for the prosecution and development of the important projects upon which it is engaged. I am recommending, also, that the name of the office be changed to "Bureau" of Farm Management and Farm Economics. If the necessary appropriation is granted, it is proposed to expand materially the studies of the cost of producing farm products and also to develop the other lines of work under way.

#### COST OF PRODUCTION.

Several valuable contributions to the available data regarding the cost of producing farm products, particularly cotton, wheat, and beef cattle, already have been made. There has been a constant

demand from the public generally, but more especially from farmers and farm organizations, for the results of these studies, and it has been repeatedly urged that they should be extended and others undertaken. There is urgent need of cost studies with reference to such crops as corn, oats, sugar beets, beans, rice, etc., and there is equal need of adequate and comprehensive studies relating to the organization of various types of farms and ranches.

Such studies furnish the farmer information which enables him to reduce expenses or otherwise to increase his profits. If he makes full use of it, he will be in position to adjust his operations from time to time to those enterprises which will yield a satisfactory profit, to add to his individual income, and, ultimately, to influence the prosperity of his community. Cost studies also inform the general public regarding the cost of producing farm products and should tend to bring about a more general realization, on the part of the consumer, of the necessity of paying prices which will adequately reward the farmer and secure the necessary supplies in the markets.

#### THE FARM LABOR PROBLEM.

The seriousness of the farm labor problem is everywhere realized. It has been present in more or less acute form for more than a decade and failure to recognize its complexity has resulted in many unwise attempts to solve it. Thoroughgoing scientific study of the whole problem is needed as a basis of action, but such a study has been impossible up to this time because of the lack of funds. During the present fiscal year, only \$5,000 is available for the purpose. While this sum is entirely inadequate to cover the whole field, a promising beginning has been made and sufficient funds should be provided for the prosecution of the work on a more comprehensive basis.

#### FARM FINANCE.

The financial problems of the farm have become more and more involved, until to-day they rank in importance with the financial problems of commercial industries. While an excellent beginning has been made in the study of farm-mortgage credit, farm insurance, and personal credit, sufficient funds are not available to deal adequately with many matters about which information is needed, including the methods employed and results obtained by farmers in attempts to improve their credit through united and cooperative action; life insurance in relation to farm finance, covering the use of life insurance contracts as a means of improving the credit of the farmer; methods of taxation as they affect agriculture; crop and live stock insurance, the need of such protection and the agencies offering it; and the place of accident and liability insurance in farming operations.

The possibilities of well-directed cooperative effort among farmers are well illustrated by what has been done in the field of mutual fire insurance. There are at present nearly 2,000 farmers' mutual fire insurance companies in the United States, with outstanding risks aggregating \$6,000,000,000. This enormous volume is carried at an average cost, for the country as a whole, of only 25 cents per \$100 per year, and, in individual cases, companies of this kind have furnished high-class protection to their members for half a century or more at a cost of less than 10 cents per \$100 per year. This result has been achieved, in part, by the elimination of unnecessary expenses of operation, of the so-called moral hazard, and of many of the physical hazards involved in farm risks.

While the department has rendered much assistance in connection with this form of cooperation, through the preparation of a suggested classification of farm risks and suitable record forms which embody the methods and practices that have proved to be most efficient in conserving farm property and in reducing the cost of insurance, a great deal remains to be done. In many States, cooperation for insurance and credit purposes is as yet little understood or practiced.

#### PERSONAL CREDIT.

It is generally recognized that one of the problems demanding special attention at this time is that of short-time personal credit for farmers. In the case of a man who has paid for his farm, the supplying of personal credit raises, as a rule, no serious question. In the case of the renter, however, and of the young farmer who is just starting out as an owner, the question of short-time credit is a difficult one. In such cases, credit can and should be based, to a considerable extent, upon character and productive ability. To deny credit to the honest, ambitious, and energetic farmer because he has little tangible security to offer is to lessen the productivity of available capital and to discourage a man who, in the future, should be a land-owning farmer. While the bankers are, in many cases, showing a commendable interest, the need is for a system which will enable the man without collateral to secure funds for productive agricultural enterprises. Without doubt, this important problem should receive careful consideration, and every feasible effort should be made to aid the farmer in obtaining the necessary personal credit.

#### THE PROBLEM OF FARM OWNERSHIP.

Closely related to the credit question is the problem of land ownership, to the solution of which national thought will, of necessity, be directed during the years that lie immediately ahead. It involves



the conditions upon which men may own the land they till; upon which young men and women, marrying and embarking upon their careers, may acquire homes where their families may be reared, educated, and brought to maturity in the essentials of good citizenship. With the passing of the great public domain, and with it our free lands, the problem has taken on added importance, and to-day represents one of the gravest social and economic questions with which the Nation has to deal.

Considerable work already has been done in this field, but it has not yet been adequately covered. Careful studies are being made of the methods of renting farm land and of improving tenant contracts, which at present are frequently inadequate. They encourage in many instances soil depletion, which, if not corrected, will, in the long run, seriously affect our production. They also encourage itinerancy on the part of tenants and constitute a barrier to community social betterment. The causes of tenancy and what it means to the country must be placed squarely before the American public so that its importance may be generally recognized. If this is to be done, studies of a thoroughgoing nature must be initiated and carried to completion.

#### PRICE OF FARM LANDS.

The price of farm lands is one of the important factors in the problem of farm ownership. It is estimated that between March, 1919, and March, 1920, the increase in the selling price of farm land and improvements was 21.1 per cent. In the last five years the increase has been 65 per cent. Although the data for the census of 1920 are not yet available, it seems probable that, while the average price of farm land and improvements per acre increased only 20 per cent during the 40 years from 1860 to 1900, the price in 1920 is two and one-half times that of 1910 and five times that of 20 years ago.

In some sections, the net return on the purchase price of farm lands is considerably less than the ordinary rate of return on first mortgages and similar investments. The rental rate of cash leases, also, is frequently less than half the rate of return on mortgages. Studies made by the department indicate that, in certain regions, the recent advance in the price of land has still further aggravated this condition. Such a situation is unfortunate, for it increases the difficulties of a tenant who is seeking to become an owner. If he borrows a considerable part of the purchase price of a farm at from 5 to 7 per cent and then finds that the investment will earn little more than 3 per cent, it will be impossible, in many instances, for him to discharge the debt.

While the increase in land prices is, to some extent, a reflection of the general upward movement in the level of commodity prices, it must be regarded, in part, as an indication of the increasing scarcity of land available for agricultural use. This scarcity is not statistically apparent, for, in addition to the area of improved land used for crops, pasture, and other farming purposes (exclusive of range land), there is nearly an equal area that is potentially available after clearing, drainage, irrigation, or for utilization by dry-farming methods. With local exceptions here and there, however, this land is either inferior to that now in use or can be made available for farming only through heavy outlays for improvement.

#### AREA EXPANDED DURING THE WAR.

War conditions stimulated an expansion of the area devoted to crops, estimated at 10.1 per cent from 1914 to 1918, or an increase of 3.4 per cent in the per capita acreage. This was effected by utilizing pasture land for crop production and by bringing into use other uncultivated areas. The expansion was particularly marked in the case of small grains. Since the armistice, there has been a reduction in crop acreage. From 1919 to 1920 there was a decline of 5.4 per cent in the acreage of 20 principal crops. Apparently, the reduction has been brought about by returning the land to pastures and by discontinuing the use of the low-grade areas which were temporarily utilized.

These changes should be instructive to those who would reduce the prices of farm products by bringing into use large areas of new land. It is clear that, if prices had been extraordinarily remunerative to the farmer compared with the returns on capital and labor in industry, we would not witness this reduction of the acreage in cultivation, but, on the contrary, a continued enlargement of it. While war conditions temporarily increased the net cash income of the farmer and stimulated a temporary expansion of the crop area, this was due in large measure to the response of the farmers to the insistent call for more food, particularly wheat and rye, the principal bread grains. It is of no small significance that the contraction in acreage has been most extreme in the case of these crops, estimated at 31.5 per cent for winter wheat, 16.5 per cent for spring wheat, and 22.6 per cent for rye.

Much loose thinking and many wrong conclusions are based on false impressions concerning the profitableness of farming. The increase in farm profits during the war was inevitably transitory. Moreover, measured in purchasing power, they shrank rapidly as a result of the rise in general commodity prices. Owing to the highly competitive character of his business and the lack of organization,

the farmer has had no effective means of preventing the impairment of his profits; his only recourse has been to migrate to the city and change his occupation, a course actually followed by many. In the light of these facts and the fear of a continued decline of profits, it is clear why the tendency to expand the crop area has been suddenly reversed.

#### LAND SETTLEMENT AND COLONIZATION.

While present conditions do not seem to justify a policy of encouraging and stimulating the extension of the farm area, it must be recognized that some new land is continually being brought into cultivation in certain regions. Moved by the spirit of adventure characteristic of Americans, by the desire to rise from the status of tenancy to the more independent status of farm ownership, by propaganda which portrays to city people in alluring fashion the attractiveness of country life, and particularly by the effective advertising and skillful salesmanship of various kinds of private land settlement agencies, men may be expected to try their fortunes in the development of raw farm land, even in periods when conditions do not favor agricultural expansion and when the net migration to cities is above the normal. It is of the highest importance that these men be enabled to embark in such undertakings with the greatest possible assurance of success, for the failure of one is likely to result in the discouragement of many.

In an earlier period of our history, the development of new agricultural areas was largely the result of the initiative of individuals. At present, it is, to a considerable extent, under the guidance of private agencies engaged in promoting the settlement and sale of land for profit. Whether the methods employed by some of these enterprises are such that private profit is not incompatible with the rendering of important service in facilitating the wise selection of land, in providing suitable arrangements for credit, and in creating conditions favorable to the success of the settlers, can be determined only by comprehensive investigation. During the past year the department has begun a study of the problem. On account of its magnitude, final conclusions may not be available for some time, but enough progress has been made to reveal the fact that numerous agencies, whose volume of business is very great, are preying on the impulse to acquire farm land, and that the results in misdirected investment of capital, futile labor through years of unavailing struggle against hopeless odds, and consequent discouragement and despair, are too serious to be ignored. The comfortable doctrine of leaving the buyer to take care of himself has been discarded in many phases of our national life. Surely, in the settlement and develop-



ment of land, the buyer should at least have full and complete information for his guidance.

It appears that under existing conditions, we should not attempt to stimulate unduly the normal rate of settlement, but rather to guide and protect the normal movement along lines which will insure a reasonable degree of success in the development of new lands with a minimum of wasted capital and human effort. It yet remains to be determined whether this purpose can best be accomplished by governmental action, by private enterprise with comprehensive attempts to educate both land-settlement agencies and prospective settlers in the methods most favorable to success, or by private agencies systematically regulated.

#### LIFE ON THE FARM.

Life on the farm and in the rural community gives rise to problems the solution of which is of vital importance to American agriculture and American civilization. It has been demonstrated that these problems are susceptible of scientific investigation. Valuable studies already have been made by the Office of Farm Management and Farm Economics, and they should be enlarged and others instituted, including especially studies relating to the human aspect of tenancy and landlordism, migration from farm life, population groups, and community planning.

In our country, agriculture, manufacture, transportation, merchandising, and professional service—strong competitors with one another for both capital and workers—are all expected to hold their own. The history of agriculture seems to show, however, that farming is in periodic danger of losing its grip on both capital and workmen and of allowing them to slip away into city industries. Statesmen have always viewed with alarm the tip of the scales from farming to industry and from country life to urban life. When the farm loses its balance to the city, the Nation is threatened with a food shortage or with dependence upon foreign countries for essential foodstuffs. But the shortage of food is not the only danger. When American agriculture begins to lose ground, the political stability of the Nation is endangered.

#### SHIFT FROM COUNTRY TO CITIES.

The returns from the 1920 census are not yet sufficiently complete to make a full statement of what has occurred during the last decade in the shifting of populations between city and country. The reports on somewhat more than one-third of the counties of the United States, however, indicate an actual reduction in the rural population in many counties of New England and New York, in some parts of

the South, and in the heart of the corn belt. Some of them lost in rural population during the preceding decade, while others are losing for the first time now. On the other hand, many rural counties in the Northwest, the West, the South, and the coast States have been gaining.

There is every reason to believe that the same causes which account for a relatively decreasing agricultural population in former decades have been at work during the past 10 years. The increased standards of living of the American people as a whole have caused a great expansion in all industries centering in cities; and the industrial bid for workers, accelerated by conditions during and immediately following the war, has been a strong magnet exerting a pull upon workers in agriculture.

The following table shows the percentage of the total number of persons employed in all American occupations who were engaged in agriculture from 1820 to 1910:

1820.....	87.1
1840.....	77.5
1870.....	47.5
1880.....	44.4
1890.....	39.2
1900.....	35.7
1910.....	32.9

We may expect for 1920 a lower percentage than for 1910; in fact, it will not be surprising if the complete returns show that only 30 per cent of our workers are farmers. It is true, of course, that increased efficiency in farming operations, resulting from the use of new and better machinery and the application of scientific knowledge, has consistently lowered the demand for labor in certain kinds of farm work, and that the labor thus released has been the first to yield to the call of the city. It is a well-known fact, also, that Army life and its accompanying set of new associations detached from farming and from rural life a considerable number of farm youth. Whether this loss is a permanent one no one can say, but, in any event, it must be considered unusual.

#### THE REAL CONCERN OF AMERICA.

The real concern in America over the movement of rural population to urban centers is whether those who remain in agriculture after the normal contribution to the city are the strong, intelligent, well-seasoned families, in which the best traditions of agriculture and citizenship have been lodged from generation to generation. The present universal cry of "keep the boy on the farm" can and should be expanded into a great public sentiment for making country life more attractive in every way. Neither force nor exhortation

will keep people in the rural districts if they are to be deprived of the benefits of modern social, educational, and other opportunities. But when farming is made profitable and when the better things of life are steadily brought, in increasing measure, to the rural community, so that farm families need not give up farming in order to satisfy their desires for the best that modern civilization affords, the great motives which lead youth and middle age to leave the country districts will be removed. In order to assure a continuance of the best strains of farm people in agriculture, there can be no relaxation of the present movements for a better country life, economic, social, and educational.

#### THE HAZARDS OF AGRICULTURAL PRODUCTION.

Given a sound basis of distribution, the curtailment of the so-called hazards of production—plant and animal diseases, insect pests, predatory animals, and rodents—with resulting increased yields per acre and reduced costs of production, will go far toward insuring a just measure of prosperity to the producer, with a fair scale of prices to the consumer. If the increasing population of the Nation is to be fed from the available farm lands in the United States, the efforts to reduce or eliminate such hazards must be prosecuted more vigorously in the future than ever before, and the fundamental research work which constitutes the basis of these efforts must have proper appreciation and support.

#### PLANT DISEASES.

The toll exacted by plant diseases is appalling. Every season, and in substantially every important producing region, they constitute a heavy handicap on crop production. When it is remembered that the cost of producing diseased and healthy crops, up to the time of harvest, is practically the same, it is clear that plant diseases are a grievous and dangerous overload on our agriculture. It has been estimated that in 1919 field diseases were responsible for the loss of approximately 190,000,000 bushels of wheat, of 78,000,000 bushels of oats, of 200,000,000 bushels of corn, of 86,000,000 bushels of potatoes, of 58,000,000 bushels of sweet potatoes, of 18,000,000 bushels of apples, and of 1,742,000 bales of cotton. The department for many years has been doing everything possible to reduce these and other losses, and excellent results have been secured in many directions.

One of the most significant activities now under way is the effort to reduce the tremendous losses from wheat rust, aggregating in some years as much as 200,000,000 bushels. Scientific investigation has proved that the fungus which is responsible for the disease gets its



start in the spring on the common barberry plant, and a vigorous campaign, therefore, is being conducted, in cooperation with the various States, to eliminate such plants. More than 4,600,000 barberry bushes have been located and of these 3,500,000 or more have been destroyed. Progress also has been made in developing a method for controlling wheat scab, which caused in 1919 the loss of nearly 60,000,000 bushels of wheat; a convenient method of testing seed corn for germination and of eliminating disease infection before planting has been devised; and much has been accomplished in working out practical control measures for other injurious plant diseases.

#### INSECTS.

The work of controlling insect outbreaks has presented many difficult and complex problems. The task, begun in 1917, of exterminating the pink bollworm, which experts in this and other countries regard as probably the most destructive pest of cotton, gave promise of success; but a new and serious situation has been presented by the discovery of the insect in a district in Louisiana not heretofore known to be infested and by its reappearance in southeastern Texas. The efforts to eradicate the pest are being prosecuted as vigorously as possible, but they are necessarily handicapped by the failure of the State of Texas to establish and enforce noncotton zones in the infested areas. Whether eradication can be accomplished in the circumstances is problematical, but, nevertheless, no steps should be omitted to prevent the additional drain on the South's most important money crop which the spread of the pink bollworm to other sections of the cotton belt would involve.

The boll weevil causes enormous damage to the cotton crop. But the Department's experts, after many years of painstaking experiments, have now found a successful method of controlling the pest by dusting the plants with calcium arsenate. As a result, the manufacture and sale of this product has reached very large proportions. Through its enforcement of the insecticide and fungicide act, the purpose of which is to insure a high standard of purity and efficiency in insecticides and fungicides used in combating plant diseases and insects, the Department is keeping off the market a great many tons of calcium arsenate of poor grade which, if used, not only would fail to control the boll weevil but would seriously damage the cotton plants.

#### THE CORN BORER.

The campaign against the corn borer, a dangerous enemy of corn, is actively under way. The insect, so far as now known, is apparently confined in this country to New England, New York, and a township in Pennsylvania, and everything possible must be done to prevent

its spread to the great corn belt of the Middle West. Two infested areas have been discovered recently in Ontario, Canada, one of them just across the lake from Buffalo and the other extending for 50 miles in either direction from St. Thomas. These areas, comprising approximately 12,000 square miles, constitute what is probably the worst infestation in North America at the present time. The officials of the Bureau of Entomology and the Federal Horticultural Board have been in consultation with the Canadian entomologists, and will cooperate with them, so far as possible under existing law, in the effort to prevent the spread of the insect into the United States at points far removed from the present infestation in this country.

#### THE GIPSY MOTH IN NEW JERSEY.

For years the department has successfully prevented the westward spread of the gipsy and brown-tail moths, great enemies of orchards and forests as well as of shade trees. It has been discovered recently, however, that a large area in New Jersey is infested by the gipsy moth, which apparently was brought in from Europe years ago, and that trees from this area have been shipped to a number of points, thus indicating the possible occurrence of the insect in other sections of the country. The Congress will be requested, at its next session, to appropriate sufficient funds to undertake the extermination of the pest in New Jersey, and, in the meantime, all shipments of trees from the infested area are being followed up as closely as possible in order to determine the other points at which the insect may have become established.

#### EMERGENCY FUND TO COMBAT INSECT OUTBREAKS.

Every year demands are made upon the department, as in the case of the gipsy moth in New Jersey, for assistance in dealing with sudden and serious outbreaks of injurious insects which often cause damage amounting to millions of dollars. As a rule, no funds are available for this purpose, and the department, therefore, is unable to take prompt and effective steps to eliminate the pests or to prevent their spread. If repressive measures were immediately undertaken, it might be possible to completely exterminate them; otherwise, the outbreaks may get entirely out of hand and make necessary greatly increased expenditures, not to eradicate but merely to control them. It would be highly desirable, therefore, to provide a special appropriation, in the nature of an insurance fund, which could be used to meet emergencies of this sort, and a recommendation to this effect has been incorporated in the estimates.

## PREDATORY ANIMALS AND RODENTS.

The systematic campaign to curtail the losses caused by predatory animals and prairie dogs, ground squirrels, and similar rodents on the western ranges has been continued. It has been estimated that these pests destroy annually more than \$300,000,000 worth of live stock, crops, and range grass. The hunters in the service of the department killed more than 25,000 predatory animals last year, and perhaps an equal number were destroyed by poisoning campaigns, resulting in a saving to the live-stock industry of more than \$6,000,000. It may be added that, since the work was begun in 1915, the skins of the animals destroyed have been sold and the net proceeds, aggregating more than \$240,000, turned into the Treasury.

## LIVE-STOCK DISEASES.

Much headway has been made by the department toward the eradication or control of live-stock diseases. The campaign against tuberculosis in cattle, begun three years ago, has aroused increasing interest among live-stock owners and State officials and has received their active support. On June 30, 1920, 3,370 herds, approximately three times the number at the beginning of the fiscal year, were officially accredited as free from tuberculosis. In addition, 16,599 herds have successfully passed one test. A total of 695,364 animals were examined during the year, resulting in the slaughter of 28,616 reactors. Applications for the testing of herds, however, have continued to accumulate more rapidly than they could be handled with the available force of veterinarians. Near the end of the fiscal year 4,740 herds were on the waiting list to be tested.

Tuberculosis is one of the greatest menaces to the live-stock industry of America. The elimination of the constant losses caused by it would materially reduce the hazards of the industry and would tend to place it on a more stable basis. The rapidity with which the disease can be stamped out depends upon the amount of money appropriated for the work. The more money that is available in the immediate future, the more quickly will the losses be reduced and the larger will be the areas freed from the scourge.

Considerable progress has been made in the control of hog cholera, the greatest limiting factor in swine production. It has been estimated that, as the result of the activities of the Department of Agriculture and of its cooperating agencies in combating this disease, a saving amounting to \$41,000,000 annually is effected. There were formerly 140 veterinarians assigned to this work, but the number has been reduced to 54 because of a curtailment in funds. The swine industry is one of the most important branches of our agriculture, and it is highly essential that the losses from cholera



be kept at the lowest possible figure. The force engaged in the work has never been sufficiently large to cope adequately with the disease and the reduction of funds has aggravated the situation.

The eradication of the cattle tick in the South continues to progress, the results in the different sections depending largely upon State, county, and local support. Fifty thousand five hundred and fifty-five square miles have been released this year from Federal quarantine, making a total of 509,080 square miles since the work was begun in 1906.

#### FOOT-AND-MOUTH DISEASE.

In addition to the task of suppressing animal diseases in this country, the department is responsible for the protection of the live-stock industry against the introduction of nearly a score of serious foreign live-stock diseases. One of the most infectious and dangerous of these is foot-and-mouth disease, which exists nowhere in the United States at the present time, but is a constant menace because of the facility with which it may be carried by animals, hides, and various live-stock products. The importance of prompt action in eliminating any centers of infection whenever they develop emphasizes the necessity of providing an adequate "insurance" fund, available for immediate use. Such a fund, to be used only in case of actual outbreaks, has been carried in the Agricultural appropriation act for several years. The appropriation was reduced by \$950,000 at the last session of Congress, leaving an amount which is entirely inadequate to cope with serious outbreaks. While, through good fortune, no outbreak has thus far occurred during the current fiscal year, it would certainly be the part of wisdom to make liberal provision for dealing with this dangerous disease whenever it appears, and the department, therefore, has recommended in its estimates for the fiscal year 1922 that the appropriation be restored to its former figure.

#### IMPROVEMENT OF CROP AND LIVE-STOCK PRODUCTION.

The elimination or control of insects and diseases affecting both plants and animals, as well as of other limiting factors, is highly essential if we are to maintain our present agricultural production. But to increase the efficiency of our farms still further requires, among other things, the development of superior plants, the improvement of cultural methods and practices, and the breeding of better animals.

The development of improved crop plants, through breeding, selection, and in other ways, has almost limitless possibilities and has received a great deal of attention both from the Department of Agriculture and the State experiment stations. It is exceedingly difficult to state accurately, in terms of dollars and cents, the value of funda-

mental work of this sort, but unquestionably it is tremendous. The efforts to develop improved varieties of corn, which have been under way for 20 years or more, have probably increased production by one-fourth. Improved wheats have added greatly to the wheat yield, and it is only necessary to mention Marquis, Kanred, Early Baart, and the new wheats of the Washington Experiment Station to realize their importance. Better potatoes have been a great factor in the production of the crop, and new varieties at present under test indicate that they mark a notable advance. The development of early velvet beans multiplied the acreage tenfold in three years, and high-yielding superior lint cottons, such as Meade, Acala, Durango, Trice, and Columbia, are of inestimable value. The recently developed Victor cowpea is far superior to any previously known. Similar, but perhaps less striking, results have been secured with most of our important crop plants, and illustrate clearly what will, without doubt, continue to be a fruitful field of activity for a large corps of investigators.

#### VALUABLE NEW PLANTS INTRODUCED.

A somewhat similar line of work is the search for and introduction, acclimatization, and adaptation of new crop plants. Some of the results in this field are spectacular, indeed almost romantic. Alfalfa, a native of Central Asia, brought into the Western States in about 1854, has become in a generation almost the basic crop of the West. The sorghums are the basis of the great agricultural development of the semiarid Southwest. Japanese rices, secured in 1899, were the foundation of the great rice industry of Louisiana and Texas. The Washington Navel orange, introduced from Brazil in 1872, makes up the bulk of the California orange industry, producing a crop valued at approximately \$16,000,000 a year. Durum wheat, introduced in 1899 from Russia, now produces a crop worth \$50,000,000 annually. Egyptian cotton, brought in by scientists of the department in 1901, has become the basis of a long-staple cotton industry in the Southwest valued at \$6,000,000 in 1917, \$11,000,000 in 1918, and \$20,000,000 in 1919. The culture of dates in California and Arizona is already a thriving business, which is expanding rapidly and will, in the near future, have impressive value. Sudan grass, introduced in 1909 from Egypt, is now worth over \$10,000,000 annually. Feterita, secured in 1906 from Egypt, produced in 1918 a crop valued at \$16,000,000. Over 1,000 varieties of soy beans have been introduced from China and other parts of the Orient. From these the experts of the department have, after careful tests, selected eight of the best varieties, which are now largely cultivated and are an important element in the very rapid increase in soy bean production. Peruvian alfalfa, introduced in 1899, is by far the most productive and valuable variety for the Southwest.

## THE SEARCH FOR GRASSES.

Scientists are convinced that there are still great possibilities in the search for new crops, especially for plants that are cultivated little, if at all, in their native countries. Perhaps this is most strikingly exhibited in grasses, many of which have been introduced accidentally. Thus bluegrass, white clover, redtop, timothy, and many others which came originally from Europe make up nearly all the grass lands of the north; and Bermuda grass from India, carpet grass from the West Indies, Dallis grass from Argentina, and lespedeza from Asia have performed a similar rôle in the South. California's pastures consist mainly of species from the Mediterranean region, such as alfalfa, bur clover, wild oats, wild barley, and numerous others. There are undoubtedly in Central Asia many species which, if properly selected and introduced, will add greatly to the carrying capacity of the western ranges, aside from what can be accomplished by rational range management. From this region came alfalfa and sweet clover, both important in the West. There is every reason to believe, also, that good grasses and legumes can be found for the cut-over lands of the South, and thus prepare the way for the further development of the live-stock industry in that section. It is impossible to bring in new grasses or other valuable crop plants from remote and almost inaccessible parts of the world without sending properly trained explorers, and larger funds for this work are needed.

## IMPROVED CULTURAL METHODS AND PRACTICES.

Better tillage and rotations, more rational irrigation, judicious fertilizing, the greater use of legumes, and proper attention to farm layout, distribution of labor, choice and care of farm machinery, and timeliness of operations, all these make for larger yields and consequently reduced costs of production. Our scientific understanding of these matters is far from adequate. Recently it has been discovered that prompt plowing under of the wheat stubble will completely destroy the Hessian fly and the joint-worm, both serious enemies of wheat. This points to the desirability of a radical change in the ordinary corn-belt rotations. On the other hand, until a rotation that is as good or better can be developed by field investigations, it is manifestly unwise to urge a change. The best rotations are organized around one or more legume crops. It is altogether likely that the failure to secure the full benefits of improved varieties of corn in the corn belt, in spite of increased use of fertilizers, is associated with the steady decline of the acreage of red clover. The restoration of red clover to its former acreage, or the finding of some other satisfactory legume, is of outstanding importance to the Middle West. Unfortunately, the facilities of the department for carrying



out these long and costly investigations to develop better rotations are wholly inadequate.

#### EFFECT OF DAYLIGHT ON PLANT GROWTH.

A striking and important discovery, made recently by the department, is that plants are remarkably sensitive to changes in the duration of the daylight period, even when all other factors are kept constant. It now seems probable that all regular periodic changes in plants, such as time of blooming, fall of the leaf, the resting period, etc., are naturally regulated by the duration of daily light. This discovery explains many plant reactions that have long puzzled investigators, such as the totally different behavior of a plant in widely different latitudes. Thus, by regulating the length of daily illumination, violets can be made everblooming and poinsettias can be forced to bloom in midsummer. The discovery undoubtedly will be of much value in greenhouse culture, and furnishes the explanation of a number of plant reactions that occur in the field. Hereafter, it must be taken into account in all accurate experimentation with plants.

#### IMPROVED TYPES OF LIVE STOCK.

The breeding and development of improved types of animals offers possibilities at least equal to those involved in the breeding and selection of better crop plants. The campaign now under way for "Better Sires—Better Stock" is producing excellent results. Its purpose is to bring about the elimination of scrub stock from our herds, thus increasing their producing capacity. It costs as much to raise a poor animal as it does a good one, and more to keep it, so that better live stock makes for increased production and greater profits. The improvement which can be made in a herd with a pure-bred male is startling. If a pure-bred sire is kept throughout, the first generation would be one-half pure blood, the second three-fourths, the third seven-eighths, the fourth fifteen-sixteenths, and the fifth thirty-one thirty-seconds, or practically pure bred.

A concrete example of the importance of quality may readily be estimated from the slaughter records of animals. In converting cattle into beef, for example, the present average dressing percentage is 53½. Poor breeding, without doubt, is a prime cause of this low percentage. Suppose our efforts to improve cattle should, within a reasonable time, raise the general dressing average only 1½ per cent—that is, to 55 per cent—what would be the resulting increase in beef? On the basis of a total annual production of 7,000,000,000 pounds, which is the average dressed-beef production for the last two years, the increase would be 200,000,000 pounds a year. This is far from being a negligible quantity; in fact, it just equals our average

annual exports of beef products for the last 10 years, including, of course, the war period.

#### BUILD UP OUR DAIRY HERDS.

Pure-bred or grade dairy cows frequently earn for their owners from 25 to 100 per cent more than the returns received from scrubs. In a typical case, heifers sired by pure-bred bulls surpassed their dams, which were ordinary cows, by 64 per cent in milk production and 52 per cent in butter fat. The second generation produced more than twice as much butter fat and milk as the original animals. The United States holds sixth place among 14 prominent countries in the average yield of milk per dairy cow, being excelled by the Netherlands, Switzerland, Denmark, Germany, and Canada. Our ability to produce scores of cows which yield more than 20,000 pounds of milk a year is ample proof that our national production of less than 4,000 pounds per year per animal is, in the last analysis, a reflection of inattention and average lack of applied skill. The dairy cow is a good example—probably the best—because her production is so readily measured and because there is so much uniform evidence in various countries. But the same principle and similar facts apply with equal force to horses, hogs, sheep, poultry, and other farm animals.

The experimental and other work of the department, having for its purpose the development and improvement of our live stock, covers a wide range, including dairy farming, hog raising, horse breeding, beef production, sheep raising, poultry production, methods of feeding under regional conditions, and the general principles of breeding and heredity. This work is of fundamental importance and should be further developed.

#### UTILIZATION OF SURPLUS AND WASTE PRODUCTS.

Along with the work of controlling diseases and insect pests, of introducing and developing better plants, of working out improved cultural methods and practices, it is essential that processes be worked out for converting perishable farm products into commodities which can be carried from the season of plenty to the season when they are actually needed. The fact that they can not now be so carried frequently results in the marketing at one time of larger quantities than can be disposed of profitably, and demoralization of the market follows, with consequent loss to the farmers. Industries founded upon the utilization of surplus farm products would be of tremendous value in meeting this problem.

The Bureau of Chemistry has accomplished some important results along this line in recent years. On the basis of its investigations, for example, there has been developed a citrus by-products in-

dustry for the utilization of cull and surplus oranges and lemons. It has also discovered a feasible method of utilizing corncobs, which always have been a waste product, so that their entire content can now be made into highly useful articles. The experts of the bureau have produced from corncobs a large yield of adhesive suitable for pasting container box board. After this is removed, a considerable quantity of a lower grade product can be made, and the residue is practically pure cellulose, which can be used in the manufacture of a number of commodities, including a good quality of paper when mixed with a suitable quantity of wood pulp. After the processes for recovering all these articles had been worked out, it was discovered that a considerable quantity of a very valuable chemical—furfural—was formed, and methods of recovering it have been developed. Furfural is a basic intermediary in dye manufacture and, in addition, has great possibilities as a solvent and as a substitute for formaldehyde in the manufacture of plastics. Many other similar lines of investigation are actively under way, but these two illustrations clearly indicate what can be done toward opening up new industrial outlets for agricultural products.

#### OFFICE OF DEVELOPMENT WORK.

It has been found, however, that the benefits of the important discoveries made by the scientists of the Bureau of Chemistry are not always fully realized. The difficulty is that of bringing about their commercial development. In order to meet this situation, there has been established in the bureau an Office of Development Work, the function of which is to aid in bringing the discoveries to the attention of business men and others. When new processes have passed the experimental laboratory stage, it becomes the duty of this new office, which is conducted by engineers rather than chemists, to investigate their commercial value and the cost and method of placing them on a commercial production basis. Efforts then will be made to inform manufacturers and business men regarding the opportunities for them to develop facilities for the utilization of the discoveries, so that the people of the country may secure full benefit of them.

#### THE AGRICULTURAL EXTENSION SYSTEM.

The broad development of the national system of cooperative extension work in agriculture and home economics under the provisions of the act of May 8, 1914 (Smith-Lever Act), is one of the most notable events in agriculture in recent years. When this act went into effect, approximately 900 counties had the services of an agricultural agent and 275 the services of a home demonstration



agent. There are now 2,000 agricultural agents and 800 home demonstration agents, in addition to 300 county leaders of boys' and girls' club work. Perhaps the most striking evidence that farmers are heartily supporting the extension service is found in the fact that this year the contributions from county sources alone aggregate \$4,780,000, compared with \$780,000 in 1914.

There are still 650 rural counties which have no agricultural agents, 1,800 are without home demonstration agents, and only a small proportion of the farm boys and girls are being reached through the club work. The desirability of completing this great system of practical education as rapidly as conditions warrant can not be questioned. There has been a great increase in the cost of travel, supplies, and, in fact, of everything required in the operation of the system, since the Smith-Lever Act was passed, and an increase of available funds each year for a number of years will be necessary if we are to reach the goal within a reasonable time.

#### WORK IN BEHALF OF FARM WOMEN.

With the spread of extension work among farm women, it has become increasingly necessary to have definite information regarding their needs and wishes, in order that the extension forces may co-operate effectively with them. The States Relations Service, therefore, undertook to make a survey, through the home demonstration agents, of 10,000 farm homes in the northern and western States. The results of the survey have been compiled and published. In brief, they show that, while there has been considerable progress in lightening the burdens of farm women and making the farm home life more satisfactory and attractive, through the introduction of labor-saving devices, improvement of farm sanitation, free mail delivery, telephones, automobiles, and the like, very much more needs to be done before the mass of farm women will have even the advantages now possessed by a limited number.

Wherever it has been in operation, the system of county home demonstration agents has proved to be the most helpful agency dealing with the problems of the farm home. It should be expanded, therefore, as rapidly as funds and facilities permit. Country life has many advantages, but they can not be sufficiently enjoyed without constant improvement in the living arrangements on the farms. We can not afford to delay bringing assistance to the farm women in solving their present pressing problems.

#### HOME ECONOMICS.

In order that the home demonstration agents may render the most effective service, there must be a constant addition to the fund of scientifically ascertained and tested knowledge in the field of home

economics. So far, research along this line has proceeded slowly and in a small way. The Office of Home Economics of the department is the largest single organization devoted to such work and has made many important contributions to our knowledge on home economics subjects. It can not prosecute its activities on an adequate scale, however, because of the lack of funds. The success of our newly established system of vocational education in home economics, provided for by the Smith-Hughes Act of 1917, as well as of the home demonstration work, depends in no small measure upon the maintenance of adequate agencies for home economics research.

#### **PUBLICATION AND INFORMATION WORK.**

The organic act creating the Department of Agriculture not only directs it to "acquire" useful information on subjects connected with agriculture in the most general and comprehensive sense of the word, but also to "diffuse" such information among the people of the United States. To meet this responsibility, increased attention has been given to the strengthening of the publication and information activities of the department. The first step involved the consolidation, in the Division of Publications, of all publication and information functions serving the department as a whole. This necessitated the transfer of the Office of Information, the Office of Exhibits, and the Office of Motion Pictures from the Office of the Secretary, combining under one administrative head these three related activities with those of editing, printing, and distribution. The next step was the designation of a Director of Information, whose duty it would be to exercise general supervision over all the publication and information activities of the department, both in Washington and in the field, and to bring about the closer correlation of such activities in the various bureaus with those of the Division of Publications. The advantages of this reorganization are apparent not only in more efficient administration and supervision but in the more complete coordination and concentration of effort.

The department is in a better position than ever before to serve the public in this important field of its work. The responsibility resting upon it is clear. It is its duty to keep the public informed regarding the results of its investigations and experiments and the administration of the various regulatory statutes entrusted to it for enforcement. Under existing conditions, however, it is compelled to reservoir much valuable information which should be made available to the public. At one time during the past year, there were 267 important manuscripts which it was necessary to withhold from publication because of the lack of funds for printing. A deficiency appropriation relieved this situation somewhat, but there are still on hand many valuable manuscripts which can not be published. This

situation should not be permitted to continue as criticism is frequently made that the results of investigations, in many instances, are published too late to be of the greatest service. Some of these manuscripts represent the life work of capable, practical, scientific men, and we should not fail to give the public promptly the benefits of their years of labor.

#### DISTRIBUTION OF FARMERS' BULLETINS.

Furthermore, the department is falling far short of meeting the demands for its publications. The law provides that one-fifth of the number of Farmers' Bulletins printed shall be available to the department, while the Congress is allowed four-fifths for distribution by its Members. The department has intimate knowledge of the needs of the country for agricultural information, and it has also an effective field organization capable of distributing its publications where they will serve the most useful purpose. It would seem desirable, therefore, to change the present arrangement so as to charge the department with the distribution of Farmers' Bulletins to the sections where the information they contain is most needed and desired.

#### THE AGRICULTURAL EXPERIMENT STATIONS.

In many of the States the institutions for agricultural research which are maintained by Federal and State funds are seriously hampered by existing conditions. Their appropriations have not been increased sufficiently to meet present economic requirements, their expert forces are being depleted by attractive offers from commercial and other concerns, and it is increasingly difficult to fill the vacancies thus created with equally competent men and women. With the increased cost of services, labor, equipment, and supplies, it has been impossible for them to maintain their prewar status in the field of research.

The situation is serious enough to deserve careful attention of all those interested in the progress of our agriculture. The research work of the stations, like that of the Department of Agriculture, is fundamental. Unless there comes from these institutions a steady and abundant flow of new knowledge which can be utilized to meet pressing problems, agricultural advancement will slow down and our system of agricultural education, through colleges, schools, and the extension service, will deteriorate.

#### NITROGEN AND POTASH.

The European war emphasized the fact that no effort should be spared to establish national independence in the production of fertilizer materials. This is especially true in the case of nitrogen,



which is not only a valuable fertilizer ingredient, but an essential element in the manufacture of munitions. Of all the nations involved in the war, Germany alone had a sufficient nitrate supply within her borders, but England, France, and Italy are now rapidly perfecting plans to make themselves equally secure in this respect. Increased interest has been manifested in this country, also, in the study of methods for fixing atmospheric nitrogen, and the Department of Agriculture, through the Bureau of Soils, has actively co-operated with the War Department in this important field. The production of ammonium sulphate from by-product coke ovens and gas plants has greatly increased, but not sufficiently to meet the demand for fixed nitrogen.

The nitrogen fixation plant at Muscle Shoals, Ala., completed shortly before the armistice, offers a hope for an independent source of nitrogen for fertilizer use in time of peace. This plant is prepared to make calcium cyanide, or, by some additions, to manufacture ammonium sulphate. With modifications, also, it may be equipped for the preparation of highly concentrated fertilizer materials which will be free from filler, and therefore result in a considerable saving to the consumer in freight charges. The plant is still idle, awaiting the necessary authority from the Congress for its operation. It is hoped that the matter will receive consideration at the next session of the Congress, and that the requisite authorization will be granted without further delay, in order that the Nation may escape, once for all, from dependence upon foreign nitrate fields, and that an adequate supply of nitrogen may be developed, both as a protection in times of national stress and to meet the growing demand for this valuable product for fertilizer purposes.

#### POTASH FROM KELP AND OTHER SOURCES.

The experimental kelp plant at Summerland, Calif., the purpose of which is to demonstrate the practicability of extracting potash and useful by-products from the giant kelps, is in active operation and valuable results are being secured. Unquestionably, it will be possible, when the best methods have been worked out, to develop a potash industry on the Pacific coast capable of supplying a considerable part of the Nation's needs.

Two processes for the recovery of potash from certain rocks have recently been developed by the Bureau of Soils, and both are being utilized in commercial practice. The 87,000 tons of potash annually lost from flues and stacks of cement plants are still, in the main, going to waste. Only about 1 per cent was recovered in 1919. A similar situation exists with reference to the collection of potash from blast furnaces. The department is now making a survey of this situation, and preliminary results

show that the dust from blast furnaces is higher in potash content than the cement dust and that it can probably be recovered more economically. The potash that escapes from these two sources would, if collected in marketable form, go a long way toward meeting the normal potash requirements of the country. There is ample justification, therefore, for the appropriation of sufficient funds adequately to study those phases of the problem which properly come within the scope of this department's activities.

#### METEOROLOGY.

Meteorology is coming into wider application in agriculture, commerce, and navigation, and the rapid development of aeronautics has opened up for it a very broad field. As a result, greatly increased demands, which it has been difficult, and in many cases impossible, to meet, have been made upon the Weather Bureau. The growth of the Nation places upon the bureau new obligations, and appropriate recommendations have been included in the estimates for the strengthening of its work, especially its studies in aid of aeronautics, so that it may be in position to meet the responsibilities imposed upon it by law.

#### THE PROGRESS OF HIGHWAY CONSTRUCTION.

It required a great national catastrophe to awaken the American public to the inadequacy of our transportation facilities and to the fact that we must depend largely upon our highways, in conjunction with motor vehicles, when a sudden expansion in transportation is essential. Our experiences during the last three years have clearly demonstrated that the failure earlier to inaugurate a sound road improvement program has retarded the effective development of one of our most vital national requirements. The use of the motor vehicle for highway transportation has increased tremendously within a short period. In 1906 only 48,000 motor vehicles were registered in the United States. By 1914 the number had risen to 1,700,000, while the registrations now total nearly 8,000,000, exclusive of motor cycles. The actual vehicle-mile use of our roads, it is estimated, has increased more than 500 per cent in strictly agricultural communities and more than 1,000 per cent near the larger centers of population. These figures indicate the extent to which community and short-haul transportation will be served by better highways.

#### GREAT HIGHWAY PROGRAM UNDER WAY.

The Federal-aid road act of 1916, as amended, has resulted in putting in motion a great program of highway development, nation wide in its extent. The original act appropriated \$75,000,000, extending over a

five-year period, for the construction of rural post roads in cooperation with the States, and \$1,000,000 a year for a period of 10 years for the building of roads within or adjacent to the national forests. It soon became apparent, however, that the sums apportioned to the various States on the basis prescribed by the act would not be sufficient to provide for the building of any considerable mileage of the more durable types of roadways such as the traffic conditions in a large number of the States demanded. After the signing of the armistice, the feeling was prevalent that there might be a period of business inactivity leading to a surplus of available labor and that a large program of road construction would be very helpful in meeting the situation. The Congress, therefore, acting upon the recommendation of the Secretary of Agriculture, amended the act, in February, 1919, by providing an additional appropriation of \$200,000,000 for rural post roads and \$9,000,000 for national forest projects, and by broadening a number of its provisions.

#### PROJECTS APPROVED AND COMPLETED.

In view of the abnormal conditions which have prevailed since the summer of 1916, the progress that has been made in placing a large highway improvement program under way is surprisingly good. In the three years, 1917, 1918, and 1919, there were approved 677 projects, calling for the construction of 5,790 miles of road and involving a total cost of \$56,418,673, of which the Federal share was \$23,931,618. During the fiscal year 1920, 1,670 projects submitted by the States, involving the improvement of 16,670 miles and a total allotment of \$109,830,366 of Federal funds, were approved. At the end of the year, 14,940 miles of Federal-aid roads, on which \$103,925,094 of Federal funds had been allotted, were under consideration and in various stages of completion, while 1,677 miles had been entirely completed. Preliminary engineering investigations have been made on 4,003 miles of forest roads and construction has been completed, or is in progress, on 1,300 miles.

#### CONSTRUCTION DIFFICULTIES.

The work of actual construction has suffered from several causes, which varied in intensity in the different States. They include: (1) The difficulty of securing transportation facilities for road materials. During the season of 1920 the assignment of open-top cars for transporting coal resulted in tying up and slowing down many of the highway projects under construction. (2) The lack of materials, particularly cement, steel, and culvert pipe. In general, the short supply of sand, gravel, crushed stone, and other similar materials has been due to transportation difficulties rather than to a shortage of production. (3) The lack of available



contractors and labor. This condition was not general, however, and was partially caused by the unwillingness of contractors to undertake new contracts rather than an actual lack of sufficient organizations. (4) Difficulties experienced in disposing of road bonds. This situation existed only in certain States and was due largely to the advance in interest rates generally after the rates for the bonds had been fixed.

There have been other difficulties, but these are perhaps the most important, and it is clear that they relate to matters over which the Federal and State highway departments have had little or no control. It has become more and more apparent that the physical tasks involved in the building of highways are so great that for a considerable period, progress will be greatly hampered by economic limitations. On the other hand, it is equally apparent that the rate of progress will be accelerated as conditions gradually become more normal. Even under the existing handicaps, a large mileage of highways is being completed. All details of engineering and administrative procedure which have been responsible for any slowing up of the work have been carefully studied, and, as far as practicable, changes designed to eliminate the causes have been made. As a result, the preliminary operations can now be carried on much more rapidly than the actual construction.

#### ADVISORY BOARD OF HIGHWAY OFFICIALS.

In order to provide for the full correlation of the work of the department and of the State highway agencies, the advisory board has been enlarged to include all the members of the executive committee and the officers of the Association of State Highway Officials. There is thus available to the department, in formulating administrative policies, the advice and experience of the State executives in actual charge of highway work, representing all parts of the country. The board functions through correspondence and periodical meetings with the Secretary of Agriculture and the Chief of the Bureau of Public Roads. One very vital question now under consideration by it relates to the classification of highways into groups or systems of like importance. This matter is fundamental to the future of highway development. Only through a carefully prepared building plan can the work of the several highway agencies, from year to year, be placed on a systematic basis, a basis that will provide systems of highways so developed and connected that all classes of traffic will be adequately served. We can not ignore the fact that the actual construction of highways will be limited by physical factors for some years to come, and it seems clear that the only sound policy to follow, in the circumstances, is that of building roads in the order of their economic importance.

Highways, as a general rule, are local institutions, and they must, first of all, carry the traffic originating in the immediate vicinity. Their normal function, therefore, is the short haul, connecting producing areas with rail shipping points and near-by markets. But we should classify our highways, and then follow the classification persistently, to the end that, as the principal roads in each State are completed, they will connect with those of contiguous States and thus automatically become links in a national system which will serve all parts of the country. In working out such a classification, due consideration must be given to the military needs, and provision, therefore, has been made for cooperation with the War Department in making an extensive study to determine the roads which are needed to meet them.

#### TECHNICAL PROBLEMS TO BE SOLVED.

With the great increase in the number of vehicles using our highways, and particularly with the greater weight of the traffic units which they are now expected to carry, many technical problems in highway construction have arisen. The solution of these problems is essential to the wise expenditure of the large sums that have been provided for construction operations. They can only be solved by painstaking and thorough investigations and studies. Plans have been worked out, therefore, for the prosecution of the necessary research work, in cooperation with the National Research Council and with educational institutions which have the requisite facilities.

#### PROVISION FOR FIVE-YEAR PROGRAM.

The rapid improvement in the organization of the Federal and State highway departments, the development of adequate road legislation in the various States, the response of the States in making funds available to meet the Federal apportionments, and the progress of construction work during a period beset with every possible discouraging condition and limitation have clearly demonstrated the soundness of the existing Federal aid plan. Future legislation should not disturb the principles embodied in the act of 1916, which have been tried out and found to be so satisfactory, and only those changes should be made which experience has clearly shown to be desirable.

The period covered by the original act, as amended, will terminate with the close of the present fiscal year. Immediate consideration, therefore, should be given to plans for its extension. In order that there may be no halting in the work, it is hoped that the Congress will, at its next session, provide additional funds, to be expended under the terms of existing legislation with certain modifications,

at the rate of \$100,000,000 a year for a period of five years, beginning with July 1, 1921. The principal modifications in mind relate to the problem confronting the Western States in highway work because of the existence in many of them of large areas of public lands, and to the maintenance of Federal aid roads by the State highway agencies rather than by the counties. The Association of State Highway Officials, at its meeting in December, 1919, unanimously approved the continuance of the present plan of Federal participation in road building with these and other modifications.

The fact that the present appropriation may not be entirely expended by June 30, 1921, does not lessen the necessity of immediate action. Both the Federal and State highway departments should know, as promptly as possible, the program for the next five years, in order that the work may be adequately planned and the engineering and administrative details carefully executed. Forty of the State legislatures will be in session this winter, when it will be necessary for them to make the requisite provision for meeting future Federal apportionments. From every standpoint, therefore, it is essential that legislation for the continuance of the program now under way be promptly enacted.

#### NATIONAL FOREST ROADS.

Provision should be made also for the continued building, on an adequate scale, of roads within or adjacent to the national forests. The forest road systems are very closely related to those of the States, and the major forest projects form important links in essential State and interstate highways. There are approximately 15,000 miles of roads within the forests which connect with State and county highway systems. The building of forest roads, therefore, is an important part of the general road development plan of the West, both within and without the forest areas. In addition, the transportation of forest products, the protection and administration of the forests themselves, and their utilization for recreational purposes are all dependent upon the construction and maintenance of serviceable roads.

#### THE FORESTRY PROBLEM.

The time has arrived when increased attention to a sound and comprehensive forestry policy is imperative. Forest depletion has reached a dangerous and critical point. As cutting advances, much of the land which should continue to produce ample quantities of timber for our domestic needs, and also a balance for export, either grows inferior or partial crops, or sinks to a condition of virtual waste. The cause is neglect and should be removed. It can be removed only by public action.



## COOPERATION WITH THE STATES.

The broad question of timber supplies and permanent forests is a national one. It can not be handled piecemeal by uncorrelated local agencies. Neither can it be handled through an inflexible system imposed without regard to local conditions. The recognized police powers of the several States should be brought into play to stop forest fires and prevent the devastation of privately owned forest land. At the same time, the Federal Government should take an active part in aiding the forest activities of the States, in standardizing technical requirements as between the States, and in extending the national forests. But the public should not be expected to bear the entire burden. Responsibility rests upon the forest owner to comply with equitable requirements designed to keep employed in growing timber lands which are not needed for agriculture.

The Congress will be asked to provide an appropriation sufficiently large to permit the department to cooperate effectively with all the States which are prepared to work with it in preventing and controlling forest fires and other causes of devastation. It will be requested, also, to provide funds for the reforestation of devastated lands within the national forests, and for additions to them through further land purchases and through exchanges of national forest areas or timber for private lands of equal values.

## FOREST EXPERIMENT STATIONS NEEDED.

Full productiveness of our forests can not be secured without full information regarding the means of controlling their growth. Unfortunately, at a time when better knowledge is particularly urgent, the machinery for obtaining it has been seriously curtailed as the result of decreased appropriations. One consequence of this has been the virtual abandonment of the forest experiment stations in the West, at which many of the most important investigations were centered. The number of these stations should be increased, not reduced. They are as necessary to forestry as the agricultural experiment stations are to progress in agriculture, and there should be at least one station in each of the main forest regions of the country. Economic studies dealing with the prospective requirements of the various industries, and, in general, with the demands which the forests of the country should be prepared to meet, also are essential. In the face of enforced curtailments in the use of wood, due to the depletion of present supplies, it is as important to study methods of economically and effectively using what we have as it is to learn how to grow more wood. Work along all these lines should be greatly enlarged and the necessary funds should be provided for the purpose.

In administering the national forests, the department has been carrying on an expanding business through a period of rapidly rising prices with an almost stationary appropriation. This has made it necessary to practice the most rigid economy. It is impossible to handle the forests efficiently on the basis of the prewar appropriations, and the protection and development of these resources should not be restricted for lack of men to handle the work involved.

#### NATIONAL FORESTS AND NATIONAL PARKS.

For many years the movement for setting aside from the public domain permanent reservations of wild lands as national heritages failed to recognize any substantial difference between national parks and national forests. As regulated use of the timber and grazing resources of the forests developed in importance, however, a clear distinction of fields began to appear. The forests, in the nature of the case, must always have an important value as recreation grounds, and must be administered with definite provision for recreational use along with the development and use of their material resources. Areas of scenic grandeur or natural wonders which are exceptional in character should be incorporated in national parks, but for every area of this sort there are literally hundreds of mountain peaks, lakes, or beautiful canyons within the forests which do not justify their designation as parks.

This situation must be recognized in seeking a sound basis for determining what areas should be incorporated in national parks. If their primary public utility arises from economic resources for which, sooner or later, there will be a legitimate demand, they should not be embraced in parks. As our Western States expand in population and industry, it will not be possible to withhold the parks from demands for water power, for irrigation, and, indeed, for timber and forage, unless they are limited to areas in which the beauties and wonders of nature are, in reality, so dominating that they justify prohibition of conflicting forms of use. Above all, the national conception of our great parks as areas so fine and wonderful that they belong to the whole country should not be cheapened by making them simply a means for local development or advertisement.

Nor should we build up, under the name of national parks, public properties which are open to various forms of commercial exploitation and which are, in fact, merely national forests under a different designation. Areas whose dominant public values are economic do not belong in the parks. They should remain or be placed in the national forests if they serve the primary functions of the forests—the production of timber or the protection of watersheds. On the other hand, the economic service rendered by the forests should be no bar to the administration of small areas at many points within them for public

recreational purposes or for the protection of their natural beauty. There is a growing demand for summer-home sites, for public camp grounds, for the development of community recreation areas in the forests, and for other forms of recreational use. To meet this demand, there should be more specific provision than has yet been made for the administration of the recreation resources.

#### GRAZING FEES.

Grazing at present is the principal source of money return to the Government from the national forests. Since 1915 the grazing fees have been doubled, with the view of making them commensurate with current rental rates for neighboring private lands of the same character. When the existing rates were established, the users of the range understood that they would remain in effect for five years and many of the grazing permits were issued for this period. The value of the grazing privilege on many ranges subsequently advanced, and a considerable sentiment in favor of an immediate further increase in the fees developed. The good faith of the Government would be impaired by such a course. Furthermore, to advance the fees at the present time would add to the instability of the national forest live-stock industry which has been brought about by existing market conditions, and would be neither just nor good public policy.

No policy has been laid down by the Congress for the guidance of the department in the exercise of the administrative discretion, with which it has been vested for 15 years, to determine the conditions under which the use of the range may be permitted. If the Congress desires to prescribe such a policy, it should not take effect until after 1923, when the existing leases will expire. Even in the absence of legislation, the department will make a classification of the ranges and fix a new scale of charges, to be imposed in 1924, under which the fees will represent the actual grazing value of the particular portion of the range used by each permittee or group of permittees. Before the new scale is determined, an opportunity will be given the local associations of national forest range users to submit any data regarding the fairness of the proposed fees which they may desire to present.

#### THE DEVELOPMENT OF ALASKA.

The Department of Agriculture, in common with a number of other departments, has very definite responsibilities in connection with Alaskan development. It is endeavoring, for example, to increase the production of crops and live stock; it has experts in the field investigating the possibility of building up the reindeer herds into an important source of meat supply; it is giving attention to the perpetuation of the fur industry. But its chief responsibility at the



present time is in connection with the administration of the national forests in Alaska.

The location of pulp mills in these forests would aid greatly in solving the problem of our future supplies of newsprint. Under regulated use, the Tongass National Forest alone can probably produce forever 1,500,000 tons of newsprint yearly, along with ample quantities of timber for local purposes. By far the most valuable timber in Alaska is that which fringes its western seaboard, the northward extension of the coast forests of Washington and British Columbia. Practically all this coastal area is owned by the Government. It is under national forest administration, and timber from it is already playing an important part in the industrial development of the Territory. Every sawmill on the coast from Ketchikan to Seward obtains its supply from the national forests. These mills furnish nearly all the lumber used in the region, and forest administration is intimately related to every form of industry and to every community in the coastal area.

#### RESPONSIBILITY OF THE FOREST SERVICE.

Because of this relation, a peculiar responsibility rests on the Forest Service in Alaska. To fulfill it effectively under a system of long-range administration is impossible. The public resources in Alaska can be properly managed only by lodging authority in men on the ground to act without waiting to consult distant superiors, and the Forest Service has consistently followed this policy. There is close cooperation between the Forest Service and the Territorial government, and the animating purpose of the forest officers is to make the forests serve the welfare of Alaska.

The greatest need of Alaska is for the investment of capital in enterprises for the development of resources which can be developed in no other way. The pulpwood supplies of the coast forests offer the best immediate opening for capital. To the task of securing their utilization on a large scale, the energies of the Forest Service are now being directed, with every promise of success. One large sale has already been closed and others are in prospect. Through such enterprises the population of the Territory will be built up, its wealth increased, and other forms of development stimulated.

#### AMENDMENTS TO EXISTING LEGISLATION.

In the early history of the Department of Agriculture its work was directed largely along the lines of research and education. In recent years, its activities have been expanded to include the administration of various regulatory laws relating for the most part, directly or indirectly, to agricultural commodities or operations. Some of

them, such as the meat-inspection act, and to some extent the food and drugs act, are designed to protect the public health. Others have for their object the protection of the live-stock industry by controlling or prohibiting the shipment of diseased animals in interstate commerce, the prevention of the entry into this country or the spread of injurious insects and plant diseases, or the conservation of our game birds and animals. Still others are intended to facilitate the marketing of farm products or to prevent abuses in the preparation and shipment of foods, drugs, insecticides, and fungicides, and of virus, serums, and toxins for combating animal diseases. Long experience in the administration of these laws indicates that many of them should be strengthened if they are to serve most effectively their original purposes and to meet new situations which have arisen since they were placed on the statute books. Appropriate recommendations regarding the necessary amendments will be submitted to the Congress at its next session; I will merely outline them here.

#### THE MEAT-INSPECTION ACT.

The meat-inspection act has been in operation 14 years and certain changes in it are clearly desirable. Authority should be given to require that carcasses and parts of carcasses, meats, and meat food products shall bear labels which will correctly indicate their kind and character. An amendment to this effect would go far toward preventing fraud and deception because purchasers would then have exact information as to what they buy. The existing doubt as to whether the law applies to shipments from a State to a Territory or to the District of Columbia, or vice versa, should be removed. In order to maintain a prosecution for the shipment of unsound meat, under the act as it now stands, it is necessary for the Government to show knowledge on the part of the shipper as to its unwholesomeness at the time he offers the product for shipment in interstate commerce. This requirement should be eliminated.

On account of the peculiar construction of section 21 of the act, there is some question as to whether the prohibition contained in it regarding the interstate transportation of unwholesome meat and meat products applies only to farmers, retail butchers, and retail dealers. There is also doubt as to whether the element of sale is necessary in order to constitute an offense under this section. These ambiguities should be corrected, and amendments should be inserted which would effectively prohibit the interstate shipment, for food purposes, of articles which become unsound subsequent to inspection, as well as traffic in unsound meats by persons who conduct their own transportation.

Specific authority should be provided for the withdrawal of inspection from establishments which violate any of the regula-

tions promulgated for the enforcement of the act, since the conditions prescribed by them are necessary to insure the wholesomeness of meat and meat food products designed for interstate shipment. Wherever the words "Inspected and Passed" and "Inspected and Condemned" appear in the statute, they should be changed to read "U. S. Passed" and "U. S. Condemned," respectively, in order to distinguish the Federal inspection marks from those of State and municipal authorities; and wider discretion regarding the disposition of fats and meat food products condemned for causes other than disease should be given, so as to permit their utilization for industrial purposes under proper regulations. The department also should be authorized to follow and reinspect products bearing the Federal mark of inspection after they have left the official establishments in which they were first examined and to cancel the marks if it is found that the continuance of their use would be misleading or an instrumentality of deception or fraud; and paragraph 545 of the tariff act of October 3, 1913, which now prohibits the importation of the classes of meat covered by the meat inspection act except under conditions prescribed by the department, but which provides no penalty for its violation, should be reenacted as a part of the meat inspection act, thus bringing it under the general penalty provisions. Other amendments of equal importance should be made, and a full statement of them will be presented to the Congress.

#### THE VIRUS-SERUM-TOXIN ACT.

In the case of the virus-serum-toxin act, a number of amendments are desirable in order more effectively to prevent the preparation and shipment in interstate and foreign commerce of virus, serums, and toxins which are worthless or contaminated. The law should be extended to cover articles which enter foreign commerce, and definite provision should be made for the destruction of worthless, contaminated, dangerous, or harmful products. Specific authority should be given to withhold the issuance of licenses to persons who refuse to permit inspection of their establishments, or to conduct them in accordance with the regulations, and a violation of the regulations at any time should be declared to be sufficient cause for the revocation or suspension of a license. It would be desirable, also, to provide that a license may be suspended temporarily, in critical cases, without the necessity of affording an opportunity for a hearing, and that all containers must bear the name of the product, the date of its manufacture, and such marks or labels as will clearly identify it and indicate its potency. The counterfeiting or falsifying of identification marks prescribed by the regulations should be prohibited; the shipment of samples of virus, serums, toxins, etc.,



intended for scientific purposes should be permitted under properly controlled conditions; and the acceptance of any money or gift by an inspector connected with the enforcement of the act, or the giving or offering of anything of value to an inspector by a licensee, should be made a criminal offense, punishable by fine or imprisonment.

#### THE FOOD AND DRUGS ACT.

In order to secure the more effective and efficient enforcement of the food and drugs act, the department should be specifically authorized to establish standards of strength, quality, and purity for the articles subject to its provisions, and ample power should be given it to enforce compliance with these standards. The term "drugs," as defined in the act, should be broadened to include specifically all cosmetics, toilet preparations, face creams, hair dyes, and antifat and antilean remedies; and all drugs containing methyl alcohol, for internal or external use, should be deemed to be adulterated, although the use of methyl alcohol in their preparation should be permitted, provided it is completely eliminated from the finished products. The list of habit-forming drugs set forth in the second paragraph of section 8 is incomplete and should be extended to include, by name, a number of dangerous substances commonly found in drug preparations; or, as an alternative, a definite requirement should be incorporated in the law that all habit-forming or poisonous drugs, or their derivatives, must be declared on the labels or packages. Virulent poisons should be brought within the scope of the act, and authority should be given to determine, from time to time, what substances shall be regarded as virulent poisons. The department should have power to inspect establishments in which foods or drugs are prepared for interstate or foreign commerce, or for sale in the District of Columbia or the Territories, in order to ascertain whether the articles are adulterated or misbranded; and the misbranding provisions of the act should be extended to food containers so made or shaped as to be likely to deceive or mislead the purchaser as to the quantity, quality, size, or origin of their contents.

#### THE INSECTICIDE AND FUNGICIDE ACT.

The insecticide and fungicide act should be amended in several particulars. A substantial minimum fine should be provided, because, in the absence of any stated minimum, fines are sometimes so small that offenders consider prosecution as a matter of small moment. Certain inconsistencies in the definitions of the two words "fungicide" and "insecticide" should be cleared up, and the doubt as to whether "fungicide" was intended to include disinfectants and antiseptics should be removed. The term "misbranded"

should be extended to cover false and misleading statements, designs, etc., in the circulars or in the advertising matter accompanying packages of insecticides and fungicides, as well as the statements upon the package or label itself, and the misbranding provisions should be made clearly applicable to inert substances which do not of themselves, or in combination with other ingredients of the particular article, prevent, destroy, or repel insects or fungi.

#### THE GRAIN-STANDARDS ACT.

The act prohibits (section 4), under penalty, the interstate shipment of grain by grade from or to an inspection point unless it has been inspected and graded by a licensed inspector. It also forbids (section 5), but without a penalty, the representation of any grain as of a grade other than that shown in the certificate issued under the act. As a result, a person who ships or sells grain by grade without the required inspection and grading is guilty of a criminal offense, while one who complies with the inspection requirement but misrepresents the grade, thereby defrauding his customer, is not. The only punishment in the latter case is the business injury resulting from the publication of the facts by the department. It seems clear, in the circumstances, that the penalty provided by section 9 of the act should be extended to cover misrepresentation of grades, including the alteration of official certificates. Specific authority also should be given for the publication of the findings of the department relating to false grading.

Under the act as it now stands, appeals respecting the grade of grain can be taken or referred to the Secretary of Agriculture only where the grain involved has entered interstate commerce. This restriction should be removed so that all persons dealing in grain who desire to avail themselves of the provisions of the act may be permitted to do so; and the present requirement that all interested parties other than those joining in an appeal must be named as respondents in the complaint should be omitted. The accurate determination of an appeal depends solely upon a proper examination of the grain, accompanied by tests of correct and representative samples, and such safeguards have been thrown around the collection of samples and the conduct of tests that the right to be heard does not aid in the determination of the true grade in any way.

#### FOOD PRODUCTS INSPECTION LAW.

The food products inspection law, at present, is limited in its operation to products shipped in interstate commerce. This limitation should be removed. The service authorized by the law is wholly permissive and in no way regulatory or mandatory and, therefore,

does not interfere with the rights of any citizen. It tends to facilitate the distribution and marketing of farm products, since it hastens the settlement of disputes as to their quality and condition upon arrival in the market, and any shipper should be permitted to take advantage of it. It would be desirable, also, to amend the law so that inspections may be made at points that can be conveniently reached from important central markets.

#### THE WAREHOUSE ACT.

Section 15 of the warehouse act requires the inspection and grading of grain, flaxseed, or any other "fungible" agricultural products covered by the act. Some grains, particularly corn and flaxseed, are not always stored as fungible products. It is customary, in certain parts of the country, to store grain in bags, or in special compartments or bins, which preserve its identity so that the identical grain may be returned to the owner when it is taken from storage. In many such cases, sampling and grading are entirely unnecessary from the standpoint of the owner. He merely wishes to be assured that the place of storage is suitable, that the warehouseman is reliable, that the warehouse is being operated under the disinterested inspection and supervision of the Federal Government, and that he is further protected against the loss of his property by the warehouseman's bond. Whether he desires to incur the expense of inspection or grading is a matter for him to determine. It seems desirable, in the circumstances, to amend the act so that the grading of grain stored in bags or in special bins or compartments which preserve its identity will not be required unless desired by the depositor. This amendment would not weaken the act in any way, but would merely meet the expressed wishes of producers in certain sections of the country. In short, it would extend to the grain grower the same privilege that the producer of corn, wool, or tobacco already has under its terms.

#### THE PLANT QUARANTINE ACT.

The plant quarantine act of August 20, 1912, needs amendment in one important particular. At present, it is difficult for employees of the Federal Horticultural Board, which is responsible for the administration of the law under the direction of the Secretary of Agriculture, to prevent the movement of infected and infested plants and plant products from one State to another when they are carried in private conveyances. The employees of the board, therefore, should be authorized to examine vehicles and other means of transportation not now covered by the terms of the act when there is good reason to suspect that they are being used for the movement of products in violation of the law and the regulations issued under it.



## THE LACEY ACT.

The Lacey Act (secs. 242 and 243 of the Penal Code), which relates to the interstate shipment by common carriers of wild animals or birds, should be amended so as to cover the transportation not only by common carriers but by any means whatever of live as well as dead animals and birds, and so as to require that packages containing game be clearly and plainly marked with a statement of the number and kinds of animals or birds therein. Provision should be made also for the more effective enforcement of the act, and duly designated employees of the department should be authorized to make arrests for violations committed in their presence, to serve warrants issued by the courts, and to seize wild animals and birds which are being illegally transported.

## ADMINISTRATION OF WILD-LIFE RESERVATIONS.

From time to time, by act of Congress and Executive orders, large tracts of land have been reserved as breeding grounds, ranges, and refuges for wild animals and birds. The administration of these reservations is committed to the Department of Agriculture. Section 84 of the Penal Code forbids hunting on the bird reservations, except in accordance with regulations prescribed by the Secretary of Agriculture. There is no statute, however, making it an offense to trespass on the refuges for wild animals, and no law which authorizes the department to administer the reservations for purposes other than the protection of the birds and animals. Neither is there any authority conferred by law upon the wardens of the reservations to arrest persons trespassing upon them. Authority similar to that contained in the act of June 4, 1897, with reference to the administration of the national forests, should be given the department to regulate the occupancy and use of the reservations, so that they may be devoted to all proper and lawful purposes consistent with the preservation and protection of the birds and animals thereon, and power to properly police them should be vested in the wardens.

## PROTECTION OF OFFICERS FROM VIOLENCE.

There is now no provision for the punishment of persons who oppose, resist, or assault employees of the Forest Service and the Bureau of Biological Survey in the performance of their duties relating to the administration of the national forests and wild-life reservations and the protection of migratory birds. These employees frequently discharge their duties under hazardous conditions. The lack of any Federal law for their protection is generally known and, in several instances, has encouraged or provoked wholly

unwarranted acts of physical violence upon them. Furthermore, the absence of such protection breeds contempt of the authority conferred by law upon the department to enforce the statutes intrusted to it for administration. Section 62 of the Penal Code accords protection to the employees of the Bureau of Animal Industry, and by a simple amendment it may be made applicable to employees of the Forest Service and of the Bureau of Biological Survey.

#### AUTHORITY TO OBTAIN INFORMATION.

A number of the statutes administered by the department require the obtaining of information, both for the purpose of properly administering them and of submitting reports to Congress upon which it may base further legislation, but the department can now obtain this information only as the persons possessing it volunteer to give it. Authority should be conferred upon the department to compel the furnishing of such information, under proper safeguards, and to permit its duly designated representatives to administer oaths and to examine witnesses in connection therewith.

#### NEW LEGISLATION.

Aside from the revision or amendment of existing statutes, experience has demonstrated the desirability of new legislation along several lines, including the following:

##### PURE SEEDS.

The importation into the United States of forage and like seeds is regulated by the seed importation act of August 24, 1912, but there is now no law to prevent the adulteration or misbranding of seeds shipped from one State to another. While it is not clear that Federal regulation of interstate commerce in seeds would be practicable, it is clear that the enlargement of the department's authority and funds for testing and other investigational work, accompanied by full publicity, would produce valuable results. It has been suggested in the estimates, therefore, that authority be given to determine the purity, viability, and trueness to variety of seeds obtained in the open market and to publish the names of the persons responsible for the shipment or sale of those which are found to be adulterated and misbranded according to the standards established by the department.

##### FEEDS AND FERTILIZERS AND NAVAL STORES.

The need for legislation to insure the purity and wholesomeness of commercial feeds intended for domestic animals and poultry has been apparent for many years. While the food and drugs act is

applicable to such feeds, it has been impossible under its provisions to prevent some of the worst forms of adulteration and misbranding. This matter should receive careful consideration, and a comprehensive law which will prevent the shipment in interstate and foreign commerce of worthless, adulterated, or misbranded feeds should be enacted as promptly as possible. In framing the measure, it would be highly desirable to give the department authority to establish standards which will adequately protect the purchaser against articles that have little or no feeding value.

There is need also of similar legislation dealing with the adulteration, debasement, and false labeling of fertilizers and naval stores.

#### ROADS.

Provision should be made, at the next session of the Congress, for the continuance of the highway program along the lines recommended on pages 51 and 52.

#### MARKETING OF LIVE STOCK.

Many measures designed to regulate and control establishments engaged in the handling of live stock and in the manufacture and preparation of meat and meat food products have been under public discussion. Several bills dealing with the problems involved are now pending in the Congress and are in various stages of consideration. Undoubtedly, it would be desirable, not only in the interest of the producer but of the consumer as well, to enact legislation which would make it impossible for those dealing in live stock and its products to exercise undue control over marketing facilities or to impose unfair or unreasonable charges for their services.

#### THE NEED OF NEW BUILDINGS.

Immediate consideration should be given to improving the housing conditions of the department in Washington. The existing situation makes for waste and inefficiency in many directions. Forty-two buildings or parts of buildings, including both Government owned and rented structures, are now occupied for office, laboratory, storage, and other purposes. They are in widely scattered locations, many of them considerable distances away from the administration building, and several are antiquated, unsuitable, and nonfireproof. The cost of maintenance, upkeep, and operation under such conditions is unavoidably large and will grow year by year.

Recently some branches of the department, at the direction of the Public Buildings Commission, which has full control over the allotment of all space occupied by the Government departments in Washington, have been placed in the temporary frame structures erected during the war. It is difficult to conceive of any type of



buildings more inflammable than these. The property and records of the Government in them are exposed to serious fire hazard at all times, to say nothing of possible loss of life in the event of fire. For what length of time it will be necessary to occupy these buildings has not been indicated, but to continue to use them indefinitely is, in my opinion, contrary to the best interests of the department.

No other department of the Government in Washington is as inadequately and unsatisfactorily housed as is the Department of Agriculture, and immediate attention should be given to the development and execution of a building program for it. The first step should be the construction of the long-deferred central building between laboratories A and B along the lines of the original designs, which are still in the files of the department, the acquisition of the land and buildings in one of the squares lying immediately south of the department's reservation, and the erection thereon of a modern fire-proof structure of plain though pleasing appearance. This would make it possible to bring the scattered units of the department closer together, to relinquish many buildings which are remotely located, unsuitable for offices and nonfireproof, and to effect a large annual saving in rentals.

#### THE PROBLEM OF PERSONNEL.

In any discussion of what the department has done during the year, it must be borne in mind that every item of progress was accomplished under serious difficulties. Rapid advances in the costs of supplies and equipment, materials, and services, and an abnormal turnover in personnel have presented many problems. Increased costs have resulted in the forced curtailment of many lines of work, and the inability to pay adequate compensation has made it impossible to establish and maintain satisfactory personnel standards.

The department is charged with duties that are extremely varied and of the utmost importance. It is conducting fundamental research in every phase of crop and live-stock production and marketing, and it is actively studying the broad economic problems in the field of agriculture. It is supervising the expenditure of the Federal funds which have made possible the inauguration and execution of the greatest road-building program ever undertaken in the history of the world. It is administering the national forests, which comprise within their boundaries 155,000,000 acres of land, and it is enforcing more than 30 regulatory laws, all of them of great importance to the people of the country. It can not hope to maintain these and other activities on a satisfactory basis, or to render the most effective service, without an adequate force of well-trained men and women. And it must not only be prepared to discharge, in full measure, its present responsibilities, but it must look to the future. Some of the most fundamental and difficult problems in agriculture

still lie ahead of us, and the planning and execution of experiments and investigations for their solution, as well as the development of the necessary machinery for conducting vigorous campaigns to eliminate the pests and diseases which are handicapping production in every direction and in every section of the country, depend for their success upon the ability of the department to secure and retain the highest type of scientific and administrative officers.

#### ABNORMAL TURNOVER.

The turnover in personnel has reached an alarming stage. Highly trained and experienced specialists and administrators are leaving the service for salaries two, three, and four times as much as the department can pay them, and many of them can not be replaced at anything like the compensation that can be offered under existing limitations. We have a record of the salaries received in outside employment by 528 of the scientific and technical employees who left the department during the fiscal year 1920. This record shows that 383 of these employees are receiving from other public institutions and commercial concerns compensation ranging from \$500 to \$7,000 more than they were paid by the department.

It is understood, of course, that the Government can not meet commercial competition. The scientific and technical men of the department do not themselves expect it. As a general rule, they are willing to accept less in order that they may remain in strictly scientific work, but they certainly should be paid salaries sufficient to keep themselves and their families in reasonable comfort. Otherwise, the Department's force will continue to be drained of many of its most efficient workers. It can not be subjected to this steady draft upon its trained personnel without serious impairment of the service, nor can it utilize the funds appropriated by the Congress most effectively with a constantly disintegrating organization and an increasing percentage of new and relatively inexperienced personnel.

#### IMPORTANCE OF RESEARCH.

The department should be in position to retain its scientific and technical workers over long periods. From the standpoint of the public service, a man once embarked upon an important field of investigation should remain there if he is capable and efficient. If he leaves to accept other employment, he carries with him much of the information he has acquired in the progress of his work, information which enriches him in experience, but which can not possibly be put on record. A new man, continuing the work, must, in many instances, go over a considerable part of the field already covered before he reaches the point where his predecessor left off.

We are at a stage of our agricultural progress where fundamental research and investigation are more essential than ever before. We

are confronted to-day with serious problems of the most pressing nature about which we know relatively little. No one acquainted with the situation will deny that it would be the part of wisdom to concentrate the best brains of the country on these problems and to provide adequate facilities for carrying on the work in the most comprehensive manner.

Since 1914 there has been no increase in the limitation on the maximum amount that may be paid to scientific and technical workers. It has been impossible, therefore, for the department to adjust their compensation to accord with the great change in economic conditions which has taken place during the past six years. This situation should be corrected without delay, and I have therefore recommended in the estimates to the Congress that the existing limitation be increased to \$6,500. I have also recommended that provision be made for increasing the salaries of the chiefs of bureaus and divisions, all of whom have large and difficult tasks to perform and are decidedly underpaid. Their present compensation is considerably less than that received by officers of similar rank in other agricultural institutions and in other branches of the Government service, to say nothing of salaries paid by commercial concerns. I can not too strongly urge that these recommendations be adopted.

The personnel difficulties which the department has experienced are not confined to the scientific and technical workers. They have extended also to the clerical and mechanical employees who, in large part, are carried on statutory rolls, which means that promotions can be made only as vacancies occur. This has resulted in a serious situation. I have suggested in the estimates some changes in the statutory rolls which, while they will not solve the problem, will afford temporary relief until such time as the Congress acts in the matter of reclassification of the salaries of Government employees generally.

#### DIRECTORS OF SCIENTIFIC AND REGULATORY WORK.

With the growth and development of the work of the department along research and regulatory lines, it is highly essential that definite provision be made for the closer coordination of these activities through a central agency. Only in this way can the most effective results be obtained. Every effort also should be made to bring about a further correlation of the research and regulatory activities with those of the appropriate State agencies. The department has no adequate machinery at this time for accomplishing these purposes. I am suggesting in the estimates, therefore, that the Secretary of Agriculture be authorized to appoint a director of scientific work and a director of regulatory work, at \$7,500 per annum each, who will devote their attention not only to the development and coordination of the research and regulatory activities of the various branches of the department but will also work out and put into execution plans



for their further coordination with similar lines of work in the various States. It is proposed that these directors shall not be subject to removal except for cause. The reason for this is obvious. In an institution such as the Department of Agriculture stability of tenure is absolutely essential if the best results are to be secured.

#### FUNDS FOR 1922.

The estimates of the Department of Agriculture for the fiscal year ending June 30, 1922, aggregate \$41,989,384, representing an increase of \$10,276,600 over the appropriation for the current year. Of this increase, \$950,000 for combating foot-and-mouth disease, \$100,000 for fighting and preventing forest fires, and \$100,000 for the control of emergency insect infestations, amounting in all to \$1,150,000, are merely insurance funds and will be used only in case of necessity. Each and every item in the estimates has been carefully canvassed, and the amount suggested represents the minimum that, in my opinion, should be provided for the maintenance and prosecution of the work of the department. It should be borne in mind, in this connection, that the appropriation for the regular work of the department during the fiscal year 1921 was reduced by \$2,186,977, the total amount provided representing a reduction of nearly \$6,000,000 below the sum recommended in the estimates for that year.

If the increase proposed is allowed, it will be possible to restore to their former status and to develop properly the important activities which have been discontinued or seriously curtailed because of the lack of funds. It will be possible also for the department to pay better compensation to its earnest and efficient workers—provided, of course, the present limitations on salaries are increased as recommended—and thus to check, in part at least, the abnormal turnover in personnel; and, lastly, the department will be placed in position to attack important agricultural problems which are pressing for solution, to enforce more completely the regulatory laws intrusted to it for administration, and to provide for the more effective administration and protection of our great national forest properties.

#### AGRICULTURAL AGENCIES EXPECTED TO HELP.

Our great agricultural industry is in the midst of a difficult and trying period. It is confronted with numerous and complex problems, and the people of the country are rightfully expecting the agricultural agencies of the Nation—the Federal Department of Agriculture, the State agricultural colleges and experiment stations, and the State Departments of Agriculture—to render increasingly important service in working out ways and means of solving them. These institutions can not hope to measure up to their responsibilities in this respect unless they are properly equipped and are placed in position to secure and retain the services of the best trained men and women in America.

A review of the activities of the department during the past year clearly indicates not only that it will be unable to give proper study and attention to the new and vital matters of national concern now demanding its attention and action, but that it can not even maintain its present standard of service to American agriculture, and through agriculture to the people of the country, without more adequate support. Unless a considerably increased appropriation is granted for the next fiscal year, it will be impossible for this great organization to deal effectively with the problems before it and it will be compelled, in many vital projects, to mark time. I recognize full well the necessity for economy in governmental expenditures, especially in view of the great financial burdens thrust upon us by the war and the present unsettled conditions; but, in my opinion, it is not true economy to fail to provide the necessary facilities and personnel for this productive branch of the Government, which is returning to the Nation manyfold, in terms of wealth created or saved, the expenditures made by it.

I have already discussed briefly the personnel situation in the department, but I wish to reemphasize it here. Important units are in danger of going to pieces because of the lack of funds to prosecute the work at hand or because present limitations on salaries make it impossible to maintain a sufficient personnel to conduct their operations effectively. This is no exaggeration. In one of the most important bureaus—one dealing with serious economic problems—8 of the 16 divisions are without directing heads because the vacancies could not be filled at the available salaries. One-half of the work of the bureau is now without adequate leadership. A similar situation exists in many other bureaus of the department, and unless it is shortly remedied stagnation will be the inevitable result. Hope of early justice in the matter of salaries and better equipment for work have encouraged many men and women to stay with the department so far, but they can not be held indefinitely if they are to meet with repeated disappointments.

I am confident that no citizen of this country, in private or public life, who has an understanding of the work of the department, of the handicaps under which our present-day agriculture is laboring, and of the national problems involved in maintaining supplies of food and raw materials sufficient for our constantly increasing population, will fail to give his sympathetic support to measures which promise increased strength to the Nation in its most basic industry, the foundation of all other industries—agriculture.

Respectfully,

E. T. MEREDITH,  
*Secretary of Agriculture.*

THE PRESIDENT.

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## REPORTS OF CHIEFS.

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## REPORT OF THE CHIEF OF THE WEATHER BUREAU.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
WEATHER BUREAU,  
*Washington, D. C., October 8, 1920.*

SIR: I have the honor to submit herewith a report of the operations of the Weather Bureau during the fiscal year ended June 30, 1920.

Respectfully,

C. F. MARVIN,  
*Chief of Bureau.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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It seems appropriate in this report to lay special emphasis upon the limitations which now surround practically all the activities and service the Weather Bureau is charged by law to render. For several years the annual appropriations of the Bureau have remained practically stationary, while costs for services and supplies of all kinds have advanced greatly. To the difficulties these conditions bring in maintaining the service of meteorology applied to the interests of agriculture, commerce, and navigation at its proper standard of completeness and efficiency there are added the necessities of meeting, as far as possible, the new demands created by simply the normal growth of the Nation as well as needs which are now a permanent part of national existence as a result of war experiences and developments. Meteorological service for aeronautics and military operations must be supplied. The Weather Bureau is the logical Federal agency for this purpose and needs the strongest possible support of Congress and the people to enable it to meet all its new obligations.

Every national activity, industry, and interest has become aroused to the immediate practical value of weather advices, warnings, forecasts, and information in the daily sequence of affairs. Aviation and the aerial mail service are protected and assured a greater percentage of safety and success by a foreknowledge of flying conditions. The total number of stations now equipped to render the special free-air data required is only 11, to represent the continental United States. Even supplemented by about an equal number of reports from Army posts and Naval bases, the number of stations is ridiculously inadequate and must be increased to meet the present demands and future growth of aviation.

Limited personnel, whose rate of pay has remained stationary with stationary appropriations, has compelled the Bureau to make numerous curtailments of useful activities. For example, it was formerly the custom for employees of the Bureau to prepare daily the large glass weather maps on the principal exchanges, boards of trade,

chambers of commerce, etc., in the larger cities of the country. Much dissatisfaction prevails whenever it is imperatively necessary, from lack of funds and trained employees, to curtail this service.

The enormous development of motor traffic and trucking has created an urgent demand upon the Bureau for weather reports and statements of road conditions for vicinities surrounding each of its principal stations: This has been met as far as possible, but the Highway Weather Service, as it is called, falls far short of supplying the motoring public with the aid and service to which it is entitled.

A new enterprise in the form of weather and rain insurance imposes other important obligations of preparedness upon the Bureau to supply facts and data this undertaking requires. This is not a burden at the present time, but is doubtless destined to crystallize into an activity which in the aggregate for the country will entail a very material added expenditure of time and effort.

Obviously meteorology can not be limited by either national or even continental boundaries. Its logical field must embrace the entire globe. Every success attained in great storm warnings and forecasts simply increases the confidence of those served and benefited, awakens greater expectations, and imposes added obligations upon the forecasters. The greatest hope in meeting this situation comes through the collection of numerous reports from the vast ocean expanses and international exchange of observations. A circumpolar service of this character, but of small extent, which existed before the war, has not yet been restored, but happily agencies are at work which give promise that the future will ultimately bring about the realization of a daily weather map, first of the Northern Hemisphere and, possibly, later of the world. In the meantime, every effort is now being directed to the restoration of the meteorological reports of the oceans.

In general terms, the Weather Bureau is suffering from the ravages of the war and the consequences of an enormous change in economic conditions. Its work is conducted under strained conditions by a faithful personnel, largely discouraged by the slow and inadequate adjustment of Federal occupations to existing conditions of life. The rehabilitation of the service is now a most urgent need.

Comments are submitted in the following regarding the principal features of the work:

### FORECAST SERVICE.

No material changes have been made in the regular forecast service of the Bureau, which was somewhat fully described in the annual report for last year. The Bureau can not adequately meet the demands for forecasting with the funds at present available. Some of the special service rendered, during the year just closed, illustrates the nature of these demands.

### SPECIAL FORECASTS AND WARNINGS.

ARMY AND NAVY BALLOON RACE.—This race was confined to officers of the Army and Navy, three balloons being entered from each of these branches of the service. It was scheduled to start at 6 p m. September 25, 1919, and complete arrangements were made to furnish



not only forecasts of surface and upper-air conditions that would be encountered, but also weather observations taken at the surface and aloft. Temporary headquarters were located at the starting grounds and telegraphic and telephonic communication established directly with the St. Louis office of the Weather Bureau. Each contestant was supplied with the observations, forecasts, and advices without delay. The information furnished was of pronounced value and the forecasts were accurate to a remarkable degree.

RECRUITING TOUR OF NAVY HYDROPLANE "NC-4."—The naval flying boat *NC-4* began its recruiting trip from Rockaway Beach, Long Island, the latter part of September, the first part being a return trip to Atlantic City, thence to Portland, Me., from which place the route extended down the coast to the Florida Straits, thence over the Gulf of Mexico to Pensacola and New Orleans, up the Mississippi and Ohio Rivers as far as St. Louis and Cincinnati, back again to the Gulf, and westward to Galveston. During this cruise, which covered several months, the Weather Bureau furnished a. m. and p. m. forecasts of weather and wind directions and velocities, both at the surface and aloft, for the aviation zone in which the boat happened to be at the time.

NATIONAL BALLOON RACE.—This race was scheduled to start from St. Louis, Mo., at 6 p. m. October 1, 1919. A special message was sent that morning stating that there would be showers and thunderstorms to the east and north of St. Louis that night and the following day, and that the conditions would not be favorable for free ballooning. A second forecast, based on special observations, was sent at 2.33 p. m. advising that the race be postponed, as the balloons would be carried northward toward the Great Lakes, where squalls and thunderstorms would be experienced. Notwithstanding this advice, the race was started at the appointed time. The contestants, 10 in number, were carried northward as predicted, and squalls, thunderstorms, and generally unfavorable weather occurred. One of the balloons, with its two occupants, was lost in Lake Huron.

TRANSCONTINENTAL RELIABILITY AEROPLANE RACE.—This race was confined to aviators of the United States Army. Starting points were San Francisco, Calif., and Mineola, N. Y., the course being a round trip between the two points. It began October 7 and ended October 31, 1919. Special forecasts were prepared for the benefit of the contestants each morning and evening during the entire period. For this purpose the route was divided into seven zones, and a separate prediction of weather that would be encountered was issued for each zone and telegraphed to the control stations. These forecasts were of great assistance to the flyers. The race was won by Lieut. Belvin W. Maynard. In commenting on the race the official news bulletin of the Air Service said:

Lieut. Maynard's wonderful time was due to the fact that he took advantage of the splendid service rendered by the Weather Bureau in sending the weather forecasts to all of the control stops. If he had been informed that the weather would be bad for the next control stop, he would immediately take off and get to this stop before the storm had approached. This enabled him to gain a distinct advantage over the other participants at the very outset of the race.

OPEN-AIR ENTERTAINMENTS AND WEATHER INSURANCE.—For many years the Bureau has been called on to furnish special forecasts covering periods of State and county fairs, round-ups, picnics, and other large assemblages in the open air. This year more applications of this kind were received than ever before. However, a new and important feature has been involved in such service, due to the rapid increase of weather insurance written by companies to cover owners and directors of such enterprises against losses due to bad weather. Extensive and expensive preparations have to be made in advance for such enterprises. The entertainments are extensively advertised to occur at stated times, and large losses are sure to occur if weather of a character to prevent attendance prevails. Insurance companies now underwrite such risks, and settlements are made on stipulated weather occurrences. The insurer and the insured are vitally concerned, especially the latter, in the forecasts that are made for them a day or two in advance of the opening, and daily thereafter if the performances continue for several days. These special forecasts are made available to the public also and are appreciated by those who expect to attend. Moreover, an important and difficult problem has been injected because of questions of settlement based on records of actual weather occurrences that naturally arise. The Bureau has been obliged to decline to install apparatus and make observations on the premises; but it has freely advised as to the kind of apparatus to be used, how the observations should be made, etc. Service to the people is incumbent on the Bureau, but it often becomes a question as to differentiation between public service and individual service. However strict an interpretation may be placed thereupon, it is patent that the rapid increase in weather insurance is bound to place large additional duties upon the Bureau in making weather observations, compiling data, and furnishing special information, all of which will severely tax the Bureau with its present limited appropriations.

#### FLYING-WEATHER FORECASTS.

A new form of forecasts, known as "Flying Weather," was begun in July, 1919, at the request of the War Department, for the especial benefit of the Air Service of the Army. The country was divided into 7 zones, and a separate forecast made for each of them in the a. m., and certain of the eastern zones in the p. m. Later the number of zones was increased to 13. These forecasts are telegraphed directly to the Air Service, which distributes them to the air fields. A typical forecast, which will explain their character, is as follows:

Zones Nos. 1 and 2: Poor flying weather to-day; local thundershowers probable; moderate to fresh south and southwest surface winds, becoming west and moderately strong above 3,000 feet.

• Similar service has been furnished the Post Office Department as an aid to mail-route aviators ever since the aerial-mail system was inaugurated. It is likely that arrangements will be made for supplying similar information for the coastal zones of the Navy. Increased demands for aerial observations and forecasts are inevitable in other directions as aerial navigation develops and as an essential factor of success. Meteorological information and forecasts are destined to become of as much importance to navigators of the air as to navigators of the seas.

## STORMS.

Although only two or three storms of extraordinary character and violence occurred, cold waves, storms, heavy snows, frosts, etc., which required the issuance of warnings and advices, were in excess of the average. It was a year of weather abnormalities which necessitated extra vigilance on the part of the forecasters. The general excellence of their work is deserving of commendation.

The most notable storm was the hurricane that occurred in September. It was first detected a little west of the island of Antigua on September 2. It passed inland near Corpus Christi, Tex., on the 14th. A detailed description of this storm was published in the Monthly Weather Review for September, 1919. It was of exceptional violence. The barometer at the center was nearly the lowest on record, and its path, after passing Key West, was abnormal. From the time it passed Key West until it struck the southern Texas coast its course was entirely over water and was beyond the range of all land observation stations. Owing to the effectiveness of the warnings that were issued few vessels remained in the Gulf of Mexico; therefore wireless reports from vessels were not available, and the forecasters of the Bureau were placed at a disadvantage in determining its course and progress.

The most violent storm that has visited the Great Lakes, measured by low barometric pressure and high-wind velocities, occurred November 29 and 30. Warnings were issued well in its advance. The winds reached hurricane force, velocities of 72 miles per hour at Port Huron, 84 miles at Detroit, and 80 miles at Buffalo and Toledo being recorded. However, so thoroughly had shipping been warned that there was not a single marine casualty—probably an unprecedented occurrence for a storm of such magnitude and intensity.

Another storm of unusual intensity passed up the Atlantic coast between February 2 and 8. Its outstanding characteristics were its slowness of movement, being nearly stationary off the Virginia coast for nearly two days, and the record-breaking tides that occurred. A unique incident of this storm was that the Weather Bureau was able to profit by its own warnings. Its observatory building at Cape Henry, Va., was seriously menaced by the high tide and encroaching waves, but advantage was taken of foreknowledge of conditions and the building was saved by the erection of sand-bag bulkheads, in which work the officers and men of the Army Engineer Corps located at Fort Story, near by, rendered invaluable assistance.

## HIGHWAY WEATHER SERVICE.

No material changes were made in the highway weather service during the year. This was due entirely to the fact that funds were not available, and that station officials were repeatedly informed that no extension of this work could be made if it involved increased expense of any kind. Bulletins giving information of the conditions of roads, the effect of weather thereon, and other information of value to automobilists and those engaged in the transportation of goods by trucks are issued from 62 stations located in 30 States.



There has been so much demand for an extension of this work, so many expressions of its value by automobile associations, road commissioners, and the traveling public that it has been difficult to resist pressure for extensions. It is a work that the Weather Bureau is best fitted to perform: its value is unquestionable, and it is hoped that appropriations may become available whereby the public demands may be met.

#### WEATHER MAPS.

The demands for the resumption of the weather maps, which were discontinued at more than 50 stations during the war, are numerous and insistent. Weather maps have been issued for more than 40 years. They are the most effective means of distributing weather information, and the educational, scientific, agricultural, commercial, and navigation interests of the country appreciate their value and expect the service in this form. No serious objection was made to their discontinuance during the war and as a war necessity. Now that nearly two years have elapsed since the war terminated, they can not understand why this service should not be resumed. However, the high cost of paper, materials, and service, which made their discontinuance necessary, have not abated. No additional funds have been appropriated, and it is impossible for the Bureau to resume the service with present appropriations. Weather maps should be resumed at a considerable number of the stations that are located in large cities and populous centers.

#### VERIFICATION OF FORECASTS.

The question of the accuracy of the forecasts and warnings issued by the Weather Bureau is of public interest. The present system of verification has not been changed for five years. The following table shows the percentage of accuracy attained in the forecasts issued for all States and sections of the country from 1915 to 1919, inclusive:

*Verification of a. m. 36-hour weather and temperature forecasts.*

Year.	1915		1916		1917		1918		1919		Average.		
	Weather.	Temperature.	Weather.	Temperature.	Weather.	Temperature.	Weather.	Temperature.	Weather.	Temperature.	Weather.	Temperature.	Combined.
Washington district:													
Northern New England.....	P. ct. 84.3	P. ct. 90.4	P. ct. 83.8	P. ct. 89.9	P. ct. 83.8	P. ct. 90.7	P. ct. 82.6	P. ct. 86.1	P. ct. 84.5	P. ct. 88.4	P. ct. 83.8	P. ct. 89.1	P. ct. 86.5
Southern New England.....	85.9	91.1	85.8	91.5	85.6	92.4	82.9	89.4	84.7	90.0	85.0	90.9	88.0
Eastern New York.....	86.6	91.2	86.2	91.5	88.1	92.2	81.4	86.6	86.4	88.1	85.7	89.9	87.8
Western New York.....	84.6	91.4	84.7	89.0	84.7	81.9	83.2	86.0	84.7	88.1	84.4	88.9	86.7
Eastern Pennsylvania.....	87.2	91.6	84.6	90.4	86.4	92.7	83.1	89.2	85.8	87.7	85.4	90.3	87.9
Western Pennsylvania.....	85.5	92.4	85.7	90.7	83.7	91.8	83.5	87.6	81.3	90.7	84.5	90.6	87.6
New Jersey.....	86.8	92.8	84.8	91.8	85.8	93.9	83.2	90.4	87.4	90.4	85.6	91.9	88.8
District of Columbia, Maryland, and Delaware...	87.5	94.2	86.2	93.4	85.9	93.9	83.8	90.1	86.3	92.0	85.9	92.7	88.3

## Verification of a. m. 36-hour weather and temperature forecasts—Continued.

Year.	1915		1916		1917		1918		1919		Average.		
	Weather.	Temperature.	Weather.	Temperature.	Weather.	Temperature.	Weather.	Temperature.	Weather.	Temperature.	Weather.	Temperature.	Combined.
Washington district:	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
Virginia.....	87.0	93.1	85.2	92.9	85.0	91.8	84.2	89.7	86.1	91.7	85.5	91.8	88.7
West Virginia.....	84.7	92.2	86.3	89.9	84.7	88.7	81.9	86.0	83.5	89.8	84.2	89.3	86.8
Kentucky.....	85.2	92.8	87.7	89.7	87.5	91.8	83.5	88.4	86.0	91.1	86.0	90.8	88.4
Ohio.....	84.6	92.2	86.4	89.8	84.6	89.7	83.4	87.9	83.7	89.4	84.5	89.8	87.2
Indiana.....	86.0	92.3	86.8	89.0	85.2	89.8	81.8	87.7	85.2	88.5	85.0	89.5	87.3
Lower Michigan.....	82.8	91.2	84.6	89.6	82.9	89.6	81.8	86.3	83.2	89.2	83.1	89.2	86.2
Upper Michigan.....	82.6	89.7	81.4	88.2	83.7	86.9	79.2	87.3	81.0	87.0	81.6	87.8	84.7
North Carolina.....	86.8	92.2	87.0	93.3	85.2	92.5	84.7	90.9	85.1	93.8	85.8	92.5	89.2
South Carolina.....	87.3	93.7	87.4	95.0	87.4	93.5	85.5	92.2	83.6	95.4	86.2	94.0	90.1
Georgia.....	87.0	94.7	87.5	94.6	86.8	92.1	85.2	92.1	82.2	94.0	85.7	93.5	89.6
Florida.....	88.6	96.6	86.6	96.3	86.7	95.8	85.6	96.2	83.4	97.3	86.2	96.4	91.3
Alabama.....	86.7	95.0	86.4	93.6	86.6	91.5	84.2	92.0	82.7	94.7	85.3	93.4	89.4
Mississippi.....	85.7	94.3	87.5	92.9	85.7	91.1	84.4	92.5	83.2	93.3	85.3	92.8	89.1
Tennessee.....	85.6	92.6	86.4	89.1	86.3	90.9	83.4	89.4	84.0	91.6	85.1	90.7	87.9
District average.	85.9	92.6	85.9	91.5	85.6	91.5	83.3	89.3	84.4	91.0	85.0	91.2	88.1
Chicago district:													
Illinois.....	84.3	92.0	86.9	90.6	87.2	91.8	83.8	89.4	86.4	90.0	85.7	90.8	88.3
Missouri.....	84.8	90.6	86.0	89.6	87.1	90.2	84.4	89.0	86.2	89.3	85.7	89.7	87.7
Kansas.....	84.6	87.6	87.3	87.1	91.0	88.3	86.0	89.0	89.2	91.0	87.6	88.6	88.1
Nebraska.....	86.2	86.4	85.3	86.0	89.5	86.3	88.2	87.4	87.4	88.5	87.3	86.9	87.1
Iowa.....	84.1	90.1	85.8	88.4	86.9	87.9	83.3	86.4	84.4	88.5	84.9	88.3	86.6
Wisconsin.....	83.2	90.3	84.8	88.8	86.1	89.3	83.4	89.3	85.6	90.0	84.6	89.5	87.1
Minnesota.....	86.3	87.5	83.8	87.5	86.5	87.2	85.3	87.6	85.3	88.1	85.4	87.4	86.4
North Dakota.....	87.5	83.9	86.2	85.9	88.9	85.3	87.5	83.2	88.1	86.7	87.6	85.0	86.3
South Dakota.....	87.4	84.8	85.0	84.2	88.5	86.0	86.6	84.6	85.8	86.4	86.7	85.2	86.0
Wyoming.....	85.8	84.7	85.9	85.9	89.7	85.2	86.5	86.4	88.9	86.8	87.4	85.8	86.6
Montana.....	83.8	84.6	85.8	85.6	88.1	82.7	87.5	84.1	89.1	85.0	86.9	84.4	85.7
District average.	85.3	87.5	85.7	87.2	88.1	87.3	85.7	86.8	86.9	88.2	86.3	87.4	86.9
New Orleans district:													
Louisiana.....	87.0	94.9	88.9	93.3	88.4	92.9	87.4	93.2	82.6	93.7	86.9	93.6	90.3
Arkansas.....	85.4	91.4	88.0	90.0	87.6	90.4	86.8	90.4	84.8	99.8	86.5	90.4	88.5
Oklahoma.....	85.3	90.2	88.3	88.5	89.2	87.7	87.1	87.9	86.9	90.6	87.4	89.0	88.2
East Texas.....	87.4	92.2	89.6	91.6	90.6	91.4	89.1	90.8	86.9	92.6	88.7	91.7	90.2
West Texas.....	90.6	90.9	94.5	90.4	94.2	91.1	93.6	90.0	89.5	92.5	92.5	91.0	91.8
District average.	87.1	91.9	89.9	90.8	90.0	90.7	88.8	90.5	86.1	91.8	88.4	91.1	89.8
Denver district:													
Colorado.....	86.7	85.8	86.7	86.1	89.1	86.2	87.1	85.9	87.7	85.3	87.5	85.9	86.7
New Mexico.....	87.8	90.7	89.0	91.2	91.2	91.1	88.4	89.2	87.4	90.6	88.8	90.6	89.7
Arizona.....	90.7	90.9	90.6	91.9	91.9	91.3	90.0	90.8	90.1	91.4	90.7	91.3	91.0
Utah.....	88.8	89.3	89.8	87.3	91.7	89.5	87.6	91.1	89.3	89.8	89.4	89.4	89.4
District average	88.5	89.2	89.0	89.1	91.0	89.5	88.3	89.3	88.6	89.3	89.1	89.3	89.2
San Francisco district:													
Washington.....	86.2	93.8	87.5	92.4	86.0	92.3	86.3	90.2	84.8	90.3	86.2	91.8	89.0
Oregon.....	87.1	89.8	89.2	89.7	87.1	89.6	83.0	87.6	84.3	88.5	86.1	89.0	87.6
Idaho.....	84.2	89.2	87.4	85.4	87.8	86.9	84.6	87.1	84.8	86.6	85.8	87.0	86.4
Nevada.....	89.4	89.8	89.3	89.0	92.2	90.2	91.9	89.7	90.1	89.0	90.6	89.5	90.1
Northern California.....	88.4	93.4	90.9	92.4	92.8	92.8	91.5	93.3	91.8	92.8	91.1	92.9	92.0
Southern California.....	91.4	96.6	93.2	97.0	94.2	95.6	90.3	95.9	93.9	95.6	92.6	96.1	94.4
District average	87.8	92.1	89.6	91.0	90.0	91.2	87.9	90.7	88.3	90.5	88.7	91.1	89.9
Grand average, all districts...	86.3	91.0	87.0	90.2	87.6	90.3	85.4	89.0	86.0	90.3	86.5	90.2	88.4

The forecast centers are located at Washington, D. C.; New Orleans, La.; Chicago, Ill.; Denver, Colo.; and San Francisco, Calif., and comprise States as indicated in the table. The combined accuracy for all the districts for the five-year period is 88.4 per cent. Veri-

fications are made of a. m. forecasts based on observations taken at 8 a. m., seventy-fifth-meridian time. These forecasts are made 36 hours in advance. It has long been recognized that the complete verification of weather forecasts, by which is meant the finding of the exact relation between the conditions forecast and those which actually occur, involves insurmountable difficulties and that approximately accurate results only are possible according to a series of relatively arbitrary rules. As verifications are based on the results of two observations a day (8 a. m. and 8 p. m., seventy-fifth-meridian time), account is taken only of precipitation or its absence during 12-hour periods. For example, the forecast "Rain to-night, fair Wednesday," would be counted a failure in the second period if some rain fell after the morning observation, although the weather was fair for the rest of the day; it would receive a credit of only 50 per cent by the rules of verification, but the public would undoubtedly regard the forecast as a complete success. In the same manner, a rain forecast for both periods would fail if the rain stopped just before the first observation of the second period.

While general rules for the verification of weather forecasts will always fail and succeed, more or less, in individual cases of the kind cited, it is nevertheless generally admitted that in such cases the failures and successes balance each other in the long run, so that after all the general averages under empirical rules fairly represent the true results.

#### RIVER AND FLOOD WARNINGS.

Increased cost of materials and services required in the upkeep of river gages, including demands for increased compensation on the part of some of the gage readers, has made it difficult to maintain the full program of activities in the safeguarding of life and property from destruction by flood.

The problem was met in part by a revision of the observational work whereby the season was shortened, wherever it could be safely done, and the small amount so saved was applied in granting small increases in compensation at the most important points. At the close of the year the revision had been completed and the maximum possible service was being rendered for the minimum expenditure of funds.

The flood-warning service has functioned efficiently throughout the year, notwithstanding the large number of unusual floods in various parts of the country. In October and November, 1919, serious flooding occurred in the region from northeast Texas to the upper Ohio Valley, and in December of that year the most severe flood in 35 years occurred in the streams of southeastern Mississippi, Alabama, and western Georgia. Notwithstanding the fact that full publicity was given to the coming of these floods, there was a small loss of life and a great loss of property, mostly unavoidable.

The floods of 1919 have emphasized the fact that matured crops grown on lands subject to overflow are not safe until removed to places not subject to overflow. This was particularly noticeable in the case of the 1919 corn crop in the lower Ohio Valley and elsewhere, much of which was lost by flood. Scarcity of farm labor may be the



explanation of a large part of the loss, but the fact remains that loss of corn in overflowed regions has been experienced for many years.

#### MOUNTAIN-SNOWFALL MEASUREMENTS.

On account of the great deficiency of snow for the winter of 1919-20 in large parts of the far West, the measurements of snowfall in mountain regions have clearly indicated the necessity of conserving the water supply in the lowlands. In one case the State has taken formal action toward conservation of the water supply. The number of mountain-snowfall stations is slowly diminishing, since it is rarely possible to replace an observer when he abandons his residence in the mountains.

#### COOPERATION.

Much valuable aid in determining the amount of snow in the mountains has been given by the forest rangers in Western States. Special acknowledgment is due the Forest Service of the Department. By a cooperative agreement with that service, an intensive survey of the precipitation in the mountains of Los Angeles and San Bernardino Counties is being made. The data collected are to be used in planning a system of flood protection for the lowlands of those counties.

The Wagon Wheel Gap county experiment station maintained in cooperation with the Forest Service of the Department, has been in operation during the year. The forest cover of watershed B has been removed in accordance with the original agreement and the experiment may be said to have reached and entered upon the second stage. A discussion of the results of meteorological and stream-flow observations during the first stage has been completed.

#### STATIONS AND ACCOUNTS DIVISION.

##### WEATHER BUREAU QUARTERS IN FEDERAL BUILDINGS.

Suspension of work on Federal buildings during the period of the war throughout the United States was so general that no new Federal buildings were completed at places where Weather Bureau stations are located, and no removal thereto from rented quarters was made during the fiscal year ended June 30, 1920. Furthermore, in several instances the urgent demand for quarters in Federal buildings by other branches of the Government necessitated relinquishment of rooms already assigned and used by the Weather Bureau as follows:

At Lewiston, Idaho, Philadelphia, Pa., and Vicksburg, Miss., one room was given up and Weather Bureau furniture and equipment crowded into remaining space. At Baltimore, Md., about one-third of the Weather Bureau space was relinquished for use of the Revenue Service. At Fort Smith, Ark., Cairo, Ill., and Sacramento, Calif., office space was rearranged to better accommodate occupants of the building.

## RENTED QUARTERS FOR WEATHER BUREAU OFFICES.

A general increase in rentals was demanded for office quarters where leases expired by limitation on June 30, 1920. Where removals to less expensive quarters and reduced space could not be effected, it was necessary to renew existing leases, and the total cost to the Bureau by reason of these increases for the next fiscal year, even attended in some cases with reduction of floor space, is \$4,548.10.

*Status of Weather Bureau offices at stations outside of Washington.*

## Free quarters and accommodations:

In observatory buildings (owned and controlled by the Weather Bureau)-----	45
In State university buildings-----	5
In Federal buildings-----	74
Total free of rental-----	124

## Rented buildings, etc., owned by individuals or corporations:

In office buildings-----	81
In buildings with grounds, aerological, and special meteorological stations-----	16

Total number rented buildings partly or wholly occupied-----	97
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Total-----	221
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The foregoing does not include Weather Bureau buildings at Narragansett Pier, R. I., and Mount Weather, Va., which continue unoccupied, in charge of caretakers.

## TELEGRAPH SERVICE.

No material changes occurred during the year in the operation of the "circuit" system whereby reception by telegraph of about 175 coded weather observations are reported to the central office twice daily. By the same means 140 stations connected directly with these circuits, 21 in number, receive a specified number adequate to their needs. In addition to these circuit reports, daily observations are received from approximately 40 other points by special message and cablegram and about 50 from ships at sea by wireless.

Close cooperation of the Western Union Telegraph Co. has existed since the foundation of the circuit system many years ago and is vitally necessary for the effective maintenance of the work. Steadily increasing use by this company of the "multiplex" machine system, mentioned in report of last year, has continued to militate somewhat against accurate and prompt transmission of reports and general miscellaneous business by special message.

Reception of reports from cable stations has not been as prompt as heretofore except in isolated cases. Several important cables were broken or interrupted at various places during the autumn of 1919. In consequence, the wireless systems of the Navy Department became greatly congested in an effort to carry the business, which included numerous daily weather reports from cable stations and also from ships at sea. Embarrassing delays naturally ensued. This condition continued throughout June, the beginning of the hurricane season, and still obtains at this writing. Vigorous efforts have been made to effect improvement without sensible results.

Refusal of one telephone and telegraph company to renew a contract at former favorable rates necessitated, in the interest of economy, transference of a large part of the service performed by that company to the telegraph companies. This amounted to about \$5,000 annually. Because of late opening of many of these offices, noted in the last report as having resulted from abridgment of the hours of labor of operators, prompt dispatch of the cotton and corn and wheat messages involved could not be accomplished. This latter condition applies equally to many small offices throughout the Middle and far Western States at which observational reports are prepared for transmission to circuit centers at early hours. At some of these points railroad offices are available from which the telegrams may be transmitted, but frequent delays are inevitable where so filed, due to the pressure of other business, especially at train times. Prompt transmission at early hours could be accomplished by the telegraph companies by assignment of special operators for this purpose, cost of which is prohibitive.

The great disparity between the wages paid commercial telegraphers and the salaries possible for the Weather Bureau to pay its operators leads to repeated resignations and vacancies for long periods before places can be filled. The work has suffered severely on this account and serious delays occur in clerical positions, leading to great dissatisfaction and inefficiency.

#### WEATHER BUREAU TELEGRAPH AND TELEPHONE LINES.

Continued extensive use has been made of facilities afforded by these lines during the year by the Navy Department, the War Department, and the Coast Guard Service, the latter having contributed as heretofore in their maintenance.

The land lines are in excellent condition and the cables are still giving regular and satisfactory service, notwithstanding all but the Key West-Sand Key cable were laid 17 or more years ago. The time is not far distant, however, when new cables must be supplied, and provision should be made by adequate appropriations for such contingency.

#### BLOCK ISLAND-MATUNUCK BEACH (R. I.) SECTION.

[Telegraph.]

Until early spring telegraphic transmission over this cable was excellent. On April 27, however, a heavy escape developed, stopping communication. Arrangements were at once begun to effect repair, which was completed on June 16 at a cost of \$829.75. Since then transmitting conditions have been excellent through the three conductors. Two conductors of this cable are rented to a telephone company for telephonic purposes. During the year the line earned \$739.68.

Prompt and satisfactory communication between the mainland and Block Island is impossible because of the inadequate facilities afforded by the Weather Bureau cable. By far the greater part of the business is conducted by telephone. The situation calls for a new cable, with at least 10 conductors, which should be owned and operated by some strong commercial company.



## NORFOLK-HATTERAS (VA.-N. C.) SECTION.

[Telegraph.]

The 172 miles of land line, including several short cables totaling about 4 miles, worked unusually well and is in excellent condition. New insulators were installed from Norfolk to Coast Guard station No. 165, a distance of about 35 miles, materially increasing efficiency. Of the four conductors in the new Manteo-Nags Head cable, one became useless in February from the effects of lightning; since then one of the two reserve conductors has been used in lieu thereof. Repair by the Coast Guard Service is expected in the near future.

Between Cape Henry and Coast Guard station No. 163, a distance of 10 miles, 10 pin cross arms were installed by the War Department in place of 4 pin arms in a first-class manner in order to provide for stringing several extra wires for the use of that department.

Because of the encroachment of the sea at Nags Head, necessitating removal of numerous cottages to a safe distance from the beach, the poles were moved back about 100 yards for a distance of 1 mile.

During April the pole line across Rudy Inlet was changed to the right of way of the Norfolk & Southern Railway Co., thus removing the line from private property.

This Norfolk-Hatteras line is of great value to the various governmental services using it and to the public generally by reason of the large amount and character of information collected and disseminated through this instrumentality.

The Coast Guard Service has cooperated most efficiently in the maintenance and improvement of the line, practically all of the repair work having been accomplished by them.

## KEY WEST-SAND KEY (FLA.) SECTION.

The cable connecting this point is owned by the Navy Department, having been laid by that department in January, 1919. No land line is operated.

## ALPENA-THUNDER BAY-MIDDLE ISLAND (MICH.) SECTION.

[Telephone.]

Land lines, 22 miles; cable,  $5\frac{1}{2}$  miles.

The total time of interruption during the year was three days on the Thunder Bay line due to necessity of repairs on the 12 miles of land line.

The lines are in fair condition except that the number of poles breaking off at the ground, due to rot, is increasing. Seventeen poles fell during the year owing to the effect of storms. One thousand dollars should be made available for sawing off and resetting those now in good condition and for replacing about 25 others. This would add approximately 10 years to the life of the line.

The naval communication service contemplates the erection of a radio-compass station on Thunder Bay Island or North Point this fiscal year if possible. The communication between the compass station and the Alpena radio station is to be maintained by two metallic circuits. One of these circuits could be made available to

both the Weather Bureau and the radio service for telephonic communication to and from the island.

This offers an opportunity for cooperation by the radio service in the matter of reconstruction and maintenance of the Thunder Bay Island telephone line.

#### WHITEFISH POINT-GRAND MARAIS (MICH.) SECTION.

[Telephone.]

No interruption of moment occurred on this line. The twice-daily reports received from Whitefish Point during navigation are of decided importance to shipping interests. The reports are addressed "Observer, Sault Ste. Marie," transmitted through to Grand Marais Coast Guard station, including the 10 miles of Weather Bureau line to Vermillion Point, thence by a private telephone line to Seney, where they are transferred to a Western Union Telegraph wire.

The country through which the private telephone wire line runs is sparsely settled. Information has been received that the line is deteriorating and that it is only a question of time when it will be abandoned.

It is understood that the Navy Department is considering placing a radio station at Whitefish Point, which will afford communication with Sault Ste. Marie, provided a 3-mile land line can be built between Detour and Detour Point. If established, this channel can be used for transmission of Weather Bureau reports to and from Whitefish Point.

#### NORTH AND SOUTH MANITOU ISLANDS-SLEEPING BEAR POINT (MICH.) SECTION AND BEAVER ISLAND-CHARLEVOIX (MICH.) SECTION.

[Telephone.]

These two worked satisfactorily throughout the year.

#### SAN FRANCISCO-POINT REYES-MOUNT TAMALPAIS (CALIF.) SECTION.

[Telephone.]

Extensive use is made of this line by the Coast Guard Service, which cooperated with the Weather Bureau in the preceding year in a reorganization plan as set forth in the report for June 30, 1919.

About 5 miles of new wire was strung by that service between Point Reyes and Fairfax, replacing faulty wire placed in the course of reconstruction of the line during the previous year.

A plan for the maintenance of the line jointly by the Weather Bureau and the Coast Guard Service was entered into April 1, 1920, which designates certain sections for which the Weather Bureau and Coast Guard will be responsible, separately. This has been of material advantage to the Weather Bureau.

A total of 1,518 messages were transmitted during the year, mostly observational reports and requests for information. No commercial business is handled.

The three test stations installed in May, 1919, and mentioned in the report for last year have further demonstrated their usefulness in locating trouble. The portion of the line between Mount Tamalpais and Mill Valley (4 miles) worked generally well throughout

the year except from July 17 to 25, during which period an interruption of six days occurred. About 1,000 messages were transmitted to and from Mount Tamalpais. The weather reports from this point are of great benefit to the service.

#### NORTH HEAD-PORTLAND (OREG.) SECTION.

[Telegraph.]

No extensive changes or repairs were made during the year, the cost for ordinary repairs being but \$9.

As detailed in the last report the Weather Bureau is permitted by the War Department the use of a conductor in the military cable between Fort Canby and Fort Stevens, the cable formerly owned and operated by the Weather Bureau between these points having been abandoned because of further unserviceability. During June the War Department laid a new section of cable for a part of the distance between Fort Canby and Fort Columbia. Much improvement in transmission has been noted. Use of the military cable is subject to recall at any time. Permanency of continuance of communication by wire between Portland and North Head, vital to Weather Bureau interests in that section, can be secured only by the laying of a new cable either by the Weather Bureau or by another agency which would assure preservation of Weather Bureau interests.

A new cable and necessary land lines would cost approximately \$25,000 to \$30,000 at this time.

#### TATOOSH ISLAND-PORT ANGELES (WASH.) SECTION.

[Telegraph.]

Length, about 90 miles. Extensive logging operations along a considerable portion of this line continued throughout the year as for several years previous, causing numerous interruptions by breaks and groundings. The number was augmented by results of road building, storms, and falling timber. Communication was thus interrupted for a total of 17 days, 88 breaks having occurred.

The span wire between Tatoosh Island and the mainland parted on July 10, resulting in an interruption of three days and four hours. A new span wire will be strung this autumn, because of faulty character of present span due to rust.

Seven hundred and fifty dollars was expended during the year for ordinary and general repairs. Much of this amount was expended for labor, the cost of which has about doubled in the last few years. About 15,000 commercial messages were handled, resulting in Government tolls of about \$2,400. In addition over 3,000 free Government messages were transmitted and about 1,500 long-distance telephone calls passed over the line.

Various alterations were made in the route of the line made necessary by town improvements, by removal from swamps, menacing forest conditions, and changing of county roadbed. Similar changes are contemplated during this year in order to improve general conditions. The line continues to be of substantial benefit to logging companies and the shipping, fishing, and commercial interests.

Regular tri-daily and special vessel reports are a special feature of the work of the stations along the line and are highly regarded by the interests served.



**AEROLOGICAL INVESTIGATIONS.****KITE STATIONS.**

Free-air observations by means of kites have been continued throughout the year at Broken Arrow, Okla.; Drexel, Nebr.; Ellendale, N. Dak.; Groesbeck, Tex.; Leesburg, Ga.; and Royal Center, Ind. These observations include daily kite flights and, whenever possible, continuous series of flights covering periods of 24 to 36 hours. Records of air pressure, temperature, humidity, and wind direction and speed are thus obtained. Brief summaries are telegraphed daily to the central office and other district forecast centers.

**PILOT BALLOON STATIONS.**

Observations by means of pilot balloons were continued at five of the kite stations (all except Drexel, Nebr.), and at Ithaca, N. Y.; Lansing, Mich.; Madison, Wis., and Washington, D. C. Early in the fiscal year this work was organized also at Burlington, Vt., and Denver, Colo. These observations are made twice daily, and the indicated wind conditions at various heights are telegraphed to the central office and other district forecast centers for use in furnishing advices to the military, naval, and postal aviation services. For the most part the balloons are assumed to have a constant rate of ascent and are followed with one theodolite only. In order to check the accuracy of the ascensional rate formula, however, observations are made with two theodolites, whenever opportunity offers, at the five kite stations.

**WEST INDIAN HURRICANE SERVICE.**

In order to add to our knowledge of the origin, direction, and speed of movement of hurricanes, plans were made late in the fiscal year to organize an aerological service in the West Indies for the period July to November, 1920, inclusive. Owing to the limited funds available, observations were undertaken by the Weather Bureau at two new stations only, viz, at Key West, Fla., and San Juan, P. R. These, however, together with similar stations organized by the Navy at Coco Solo, Canal Zone, and Santo Domingo, Dominican Republic, and several already in operation in the Gulf States, form a network of stations which, it is believed, will furnish information of much aid in the study of these destructive storms and in forecasting their direction and rate of movement. It is to be hoped that this service may be greatly extended during the next two or three years.

**COOPERATION.**

Throughout the year cooperation with the Army and Navy meteorological services has not only been maintained but has been rendered considerably more effective than heretofore. In addition to the two balloon stations established by the Navy in the West Indies, already referred to, about a dozen similar stations are operated by these two services in various parts of the United States. These stations are so distributed with respect to those of the Weather Bureau that the country east of the one hundredth meridian is well

covered. Observations are made and telegraphed in the same manner as are those at the Weather Bureau aerological stations.

Special observations were made during the year in connection with the trans-Atlantic flight of the British dirigible *R-34*, the Army and Navy race from St. Louis, and the recruiting trip of the *NC-4*.

#### CENTRAL OFFICE.

All observations made at kite and balloon stations, Weather Bureau, Army, and Navy, are forwarded to the central office of the Weather Bureau for final reduction and study. Data based upon these observations are furnished in answer to numerous inquiries not only from other Government departments but from commercial aviation concerns as well. A summary of aerological investigations at Drexel, Nebr., was published and widely distributed. Similar summaries for the other kite stations are in preparation. Several papers, containing discussions of aerological data and their application, were published, and work was begun on an aerological survey of the United States east of the Rocky Mountains based upon all kite and balloon observations thus far obtained.

#### CLIMATOLOGY.

The work in climatology during the fiscal year just closed was carried forward mainly along the lines pursued in previous years.

The somewhat deranged conditions of the observing force at numerous stations, due to frequent changes, tended to less accurate work and thereby added to the work of the checking and verification. Frequent changes in the clerical force and a lessened efficiency, due to the general lowering of the morale, have hindered progress and added materially to the labors of the more responsible supervising employees.

On the whole, however, the station forms work has been nearer the standard required than might have been expected and much credit is due to officials in charge of the several stations for the diligence shown in securing good work under the frequently continued handicap of untrained assistants.

A considerable increase in work to meet the needs of aviation has been entailed by the call for wind movement and duration from the different direction points, but it is thought the data finally summarized from all sources are believed to be of the high standard usually maintained.

No change has been made in the manner of presenting the climatic statistics gathered by the Bureau, save in the case of Form 1030, Monthly Meteorological Summary, issued at the close of each month from practically all stations. This form has been revised to include much additional material pertaining to the hourly temperature and moisture values, as well as additional comparative data, and is now being issued at practically all stations provided with proper printing facilities. Also the policy of encouraging the press to print in their daily issues more data on moisture, inaugurated last year, has continued, and this is now being accomplished satisfactorily at the majority of stations.

## CLIMATIC DATA.

The various tables, charts, and discussions of weather conditions for the Monthly Weather Review and the Annual Report of the Chief of the Weather Bureau, emanating from the division, were prepared in the usual form. Special effort is being made to secure each year more complete statistics on the occurrence and distribution of hail and the amount of damage from tornadoes and other windstorms for publication in the section reports as well as in the Annual Report of the Chief of the Weather Bureau. It is also contemplated adding to the last-named publication the summarized data on evaporation now being accumulated.

The monthly and annual climatological reports for the several States were issued as in previous years, although considerable delay has occurred at several sections due to insufficient printing force. In the absence of any criticism it is assumed they present the data in the form desired by the public, and despite continued efforts to economize in their issue on account of the high cost of production the mailing lists continue to grow.

## COOPERATIVE STATIONS.

As in previous years, effort has been directed toward improved character of records made by the several thousand cooperative observers, rather than to extend their number. This has been accomplished in the main, although some departures from the established regulations governing the distribution of these stations have appeared necessary. On the whole, however, the number of stations has not been materially increased, and opportunity has been afforded in several instances to reduce fully equipped stations to the status of rainfall stations only, so that the number of full temperature and rainfall stations probably remains about as in previous years.

Owing to a general spirit of unrest, changes in observers were probably more frequent than in previous years, this being more especially the case where the observations are maintained by corporations, railroad companies, and municipal institutions. Considering all factors affecting the cooperative work, it is really remarkable that, with labor at such a premium, so many people are willing to give the time necessary to perform this work without a thought of remuneration. In fact, a recent attempt on the part of one or two observers to form an organization of cooperative observers to demand a place on the Government pay roll met with almost universal condemnation and refusal to associate for such a purpose.

## INSPECTION OF STATIONS.

The policy adopted several years ago of inspecting the cooperative stations at least once in each three years was carried out as fully as the funds and the general shortage of help at the section centers would permit. The extent of these inspections, however, fell far short of the program outlined and that really necessary to maintain the service at the highest standard of efficiency.



It is becoming more and more apparent that only by frequent contact with the officials of the Bureau and a persistent propaganda of encouragement is it possible to maintain among the less enthusiastic observers that unflagging interest so necessary for a continuity of records that will faithfully portray the climate at the point of observation.

#### STATION PUBLICATIONS.

On account of the frequent changes in the working force at a few of the printing stations and the employment of inexperienced help, the issue of the monthly summaries for several States has been much delayed and the work of assembling, binding, and distributing these combined reports was, as a consequence, greatly hindered. Likewise the annual summaries, 1919, for several States were still unpublished at the close of the fiscal year. These reports serve their best if issued promptly, and it is believed this condition could be improved and at the same time some economies in both labor and funds accomplished by strengthening the printing force at a few stations so that groups of States might be issued from a single point. This, of course, could not be extended to more than three or four States, as some sections would necessarily be always late. It would also afford an opportunity to help out a section where the printer might be sick or where frequent changes had prevented prompt issue.

#### CENTRAL OFFICE PUBLICATIONS.

At the beginning of the winter of 1919-20, the Snow and Ice Bulletin, heretofore issued as a separate publication by this division, was merged with the National Weather and Crop Bulletin and so continued throughout the winter. The preparation of the material for that portion of the bulletin was continued by the division, but, on account of limited space, the tables of statistical data were not as full as formerly, although the charts showing the distribution of the winter's snowfall were made somewhat more comprehensive than in previous years, including generally more data from the high mountain regions of the West.

On account of lack of funds only a few reprints of the exhausted sections of Bulletin W were provided for, and much inconvenience has been experienced in answering requests for weather data from those now exhausted. A number of these have been prepared for reprinting, and it is hoped opportunity will be afforded during the present fiscal year to issue several of the more important sections.

The climatology of Hawaii in much detail, prepared by the official in charge at Honolulu and revised at this office, is now awaiting an opportunity to print, and similar data for Alaska now largely under way should be made available to the public as soon as possible.

A complete revision of all the sections of Bulletin W, bringing the tables down to 1920, and enlarging somewhat on the amount of material presented, particularly in sections where, on account of specialized industries, weather changes and possibilities are factors of the utmost importance, should be provided for as soon as possible.

## WORK ACCOMPLISHED DURING THE YEAR.

Requests for data from all classes of our citizens, from the courts, from corporations, and industrial interests, continued with increasing volume. Publications available for distribution afforded a convenient means of answering many of these requests. In many other cases, however, it was necessary to extract material from the original records. All were answered as fully as possible, and in no instance, as far as official records show, was dissatisfaction expressed at the effort made to meet the wishes of the applicant. On the other hand, hundreds of letters, voicing keen appreciation for the intelligence displayed in interpreting and frequently anticipating the needs of those applying for information, have been received.

## OCEAN METEOROLOGY.

In recognition of the increasing importance of marine meteorology consequent upon the growth of our merchant marine and the developments in transoceanic flight, the marine work of the Bureau was organized as a division of the central office, effective April 1, 1920. Prior to that date the work at Washington was conducted by the marine section, a branch of the climatological division. Outside of Washington marine work is carried on by officials of the Bureau located at the principal ports, in connection with other duties.

During the year the marine work progressed along the usual lines. There was a substantial and satisfactory increase in the number of reports received from ships, sufficient to warrant the expectation that the total number will shortly equal or possibly exceed that of the prewar period. Every effort was made to secure additional reports.

The examination and charting of reports from the North Atlantic Ocean was continued and some tentative work done in connection with the charting of reports from the North Pacific Ocean. Summaries of weather conditions over both these oceans were published in the Monthly Weather Review, and tracks of the more important storms furnished the Hydrographic Office, under departmental arrangement, for publication on the pilot charts. An increased amount of data was supplied for use in Admiralty cases. Officials at Weather Bureau offices located at the principal ports were actively in touch with maritime interests.

The safe and economical operation of ships depends largely upon a fundamental knowledge on the part of their officers of the weather of the oceans. If the United States is to succeed in its efforts to conduct an extensive merchant marine, one of the necessary conditions is that it add to the present-day knowledge of ocean or marine meteorology. The Weather Bureau is the governmental agency charged by law with the duty of furnishing meteorological information in the aid of navigation and has been earnestly endeavoring to meet the demands upon it in this field. War and postwar developments have, however, broadened these demands until the Bureau is unable adequately to meet the needs of the situation with the resources now at its command.

### AGRICULTURAL METEOROLOGY.

The principal routine work of this division is the collection of temperature and rainfall data and the effect on crops and farm operations and the publication of this information in weekly weather and crop bulletins. These reports are issued at 11 a. m. Wednesday and cover the weather conditions up to 8 a. m. Tuesday. The National Weather and Crop Bulletin is issued at Washington, while local bulletins are published at the section centers in each State. A special Corn and Wheat Region Bulletin is published weekly at Chicago covering the grain-growing States, and a special Cotton Region Bulletin is published at New Orleans covering the cotton belt. There is a growing and insistent demand for these reports, especially for the National Weather and Crop Bulletin.

The weekly issue of the National Weather and Crop Bulletin was continued throughout the winter months and was combined with the Snow and Ice Bulletin, which heretofore had been published as a separate report. This arrangement was found so advantageous that it will be continued in the future, as it seems important to give information each week on the effect of snow cover, or lack of it, on meadows and grain fields, the effect of high or low temperatures on fruit and southern truck crops, and the effect of weather on ranges and stock.

#### SPECIAL SERVICES.

The collection of temperature and rainfall data and the publication of daily bulletins were continued in the principal grain, cotton, sugar, and rice States. This service should be extended to include the grain-growing districts of Wyoming, Virginia, West Virginia, Maryland, and Pennsylvania. The weekly collection of data in the range districts in Texas, New Mexico, Arizona, Utah, and Wyoming was continued. This service should be extended over Montana and other winter-grazing States. The collection of meteorological data from special stations in the tobacco, fruit, truck, and alfalfa-seed districts was continued during the critical periods to aid in issuing warnings and damaging temperatures.

The special weather-warning service for spraying operations was extended to additional counties in western New York and into the central and lower Hudson Valley in the eastern part of the State. Special forecasts appear to be essential in determining the proper time for spray applications in all fruit districts. The special investigations in the citrus and deciduous fruit-growing districts of the Pacific coast were continued and resulted in the publication of Farmers' Bulletin 1096, "Frost and Prevention of Damage by It."

#### COOPERATION.

Cooperation was continued with other bureaus of the Department in maintaining special meteorological stations at various points in different sections of the country, as an aid to research and investigations of the many agricultural problems in which weather is an important factor.



**EFFECT OF WEATHER ON CROPS.**

It has been determined that most crops have a critical period of growth, usually short, when favorable weather will cause a good yield and unfavorable weather a poor yield, regardless, mainly, of earlier or later weather conditions. Studies to determine this critical period are carried on as far as time and opportunity will permit. Some of the studies carried to completion relate to the effect of temperature, rainfall, and snow on winter wheat, cultivation and rainfall in the Great Plains, relation between precipitation and the grazing capacity of ranges, the seasonal distribution of precipitation, and sunshine in the United States.

The greatest need in this direction is the establishment of agricultural meteorological stations at the agricultural experiment stations in the principal crop-growing areas. When established a careful and systematic record can be begun of the temperature, rainfall, sunshine, etc., and at the same time a complete record of the development of the various crops. By maintaining these stations for a period of years, the most critical period of growth and the weather factor most affecting the crop can be determined.

**WEATHER BUREAU PRINTING OFFICE.**

The principal publications issued during the year included the Daily Weather Map, Monthly Weather Review, and Supplements, Daily River Stages at river-gage stations in the United States for 1918, National Weather and Crop and Snow and Ice Bulletins combined, forecast cards, weekly forecast, and Form 1030, Monthly Meteorological Summary for Washington, D. C.

At the end of the year there were 934 paid subscribers on our various mailing lists, exclusive of the Monthly Weather Review, and the total receipts from subscriptions amounted to \$823.97. Subscriptions for the Monthly Weather Review are received and filled by the superintendent of documents, Government Printing Office, who requires 200 copies each month.

The amount allotted the Weather Bureau for printing and binding at the Government Printing Office is inadequate, and, as a consequence, several important publications had to be suspended until the allotment for the present fiscal year became available.

**MONTHLY WEATHER REVIEW.**

The increased size of the Monthly Weather Review, occasioned by the larger number of contributions received during the year following the signing of the armistice, was maintained until January 1, 1920, when a reduction of 30 per cent was rendered necessary by the low state of the printing funds. Although the sections dealing with the weather and earthquakes of the month were condensed somewhat, the major portion of the cut fell on the section devoted to original contributions. During the remainder of the fiscal year this resulted in an appreciable increase in the number of papers awaiting publication and also in a reduction in the supply of new contributions received, for lack of ready publication tends to dampen the enthusiasm of potential contributors. That the Monthly Weather Review is

becoming more and more appreciated, and therefore is playing a useful rôle in the development of meteorology, is shown by the necessity of increasing the edition published from 1,525 for the last number in fiscal year 1919 to 1,750 for the corresponding issue a year later. Even with 1,750 copies published, the supply of the last three issues held for sale has been exhausted. A large part of the increases in demand came through paid subscriptions, which nearly doubled.

In addition to the usual editorial work, the results of investigations undertaken mainly in the interests of improved general and local forecasting, especially of winds at flying levels, were prosecuted and published. Specifically, these were—clouds and their significance, effect of winds and other weather conditions on the flight of airplanes and balloons, sleet and ice storms (glaze), preliminary steps in the making of free-air pressure, and wind charts. Reprints of the articles on weather and aeronautics were distributed to all aviators of the Army and Navy. During four months daily open-air instruction and lectures on clouds and their significance to classes of naval meteorological officers were given.

### LIBRARY.

During the fiscal year 1,050 books and pamphlets were added to the library, the strength of which is now over 39,000. Political changes brought about by the war have greatly complicated the work of libraries in which, as in the case of the Weather Bureau library, a large part of the collection is classified and shelved according to geographical divisions. Reclassification of many books to take account of recent changes of this character is in progress. The same cause has made necessary an extensive revision of the foreign mailing lists of Weather Bureau publications, and this has been carried out by the librarian. A marked growth of interest in meteorology that has followed the war is indicated by the large number of requests which the library now receives from all parts of the United States and elsewhere for information and the loan of books.

### INVESTIGATIONS IN SEISMOLOGY.

The important work of collecting and publishing earthquake data, begun December 1, 1914, has been continued during the year.

During the calendar year 1919, 86 separate earthquakes, strong enough to be felt, were reported from different parts of the continental United States. The great majority of these produced no damage whatever, and none produced any important damage. No important earthquakes occurred in our outlying possessions.

### VOLCANOLOGY.

The work in volcanological observations is conducted at the crater of the volcano Kilauea, Hawaiian Islands, and was taken over by the Weather Bureau on the 15th of February, 1919, under an appropriation by Congress of \$10,000, which has been continued yearly since that time. The funds available have been just adequate to carry on the routine activities of observational work organized a number of years ago under the direction of Dr. James A. Jaggar, jr., origi-

nally of the Massachusetts Institute of Technology and now in charge of the work under the Weather Bureau. On special occasions the observations are extended to include the volcano at Mauna Loa. A visit to some part of Mauna Loa more than once a year is desirable. Experience proves that Mauna Loa erupts more frequently from places along its rift systems outside of the summit crater than at the summit crater itself. There has been no activity at the summit crater during the 1919 outbreaks from the south flank, and in 1920 Mauna Loa is quiet.

Seismometric registration has continued as heretofore, with no unusual events during the period. The Hilo instrument has been operated nearly continuously.

The general results of observations at Kilauea are brought together from month to month in a small bulletin, which is issued regularly. In addition, a summary has been issued to newspapers and printed with fair regularity.

### INSTRUMENTATION.

The instrumental equipment of the field stations has been maintained in a serviceable condition, but at a number of stations repairs to roof equipment needed could not be made owing to difficulty in getting satisfactory estimates.

### STORM-WARNING EQUIPMENT.

The three-lantern system was completed during the fall, and is now in effect throughout the country. The storm-warning equipment destroyed in the Corpus Christi district by a hurricane is now being replaced, the larger portion of the expense coming out of funds for 1920. Few additions or improvements have been possible with the limited funds at our disposal.

### NEPHOSCOPES.

The Bureau now has at the factory ready for distribution 100 nephoscopes of a new pattern.

### EVAPORATION.

The evaporation stations have not been increased in number, on account of expense and because it was thought best not to add to the duties of stations at this time.

### INVESTIGATIONS IN SOLAR RADIATION.

Observational work has been maintained at Washington, D. C., Madison, Wis., Lincoln, Nebr., and Santa Fe, N. Mex., as in previous years.

A summary has been prepared of the measurements made previous to July, 1919, and utilized in the determination of average monthly sunshine intensities in the United States east of the Rock Mountains. These have been published in the Monthly Weather Review for November, 1919, in the form of charts, which are the only sunshine intensity charts yet published for any country.



The above summary also has served as the basis for determinations of the intensity of direct solar illumination, and of the illumination from the sun and sky, which latter is commonly called daylight intensity. These results are also published in the Review for November, 1919, in the form of diagrams, by means of which the illumination of surfaces normal to the incident solar rays, of horizontal surfaces, and of vertical surfaces variously oriented, may be determined for different parts of the United States east of the Rocky Mountains, at any hour of any day of the year, under average clear-sky or overcast-sky conditions.

On account of the few points at which solar radiation measurements have been made, the above results must be considered as a first approximation only. With a view to providing for additional observing stations, two new Marvin pyrliometers were constructed and standardized during the year, and a few pyrliometric measurements were made at points in California and Oregon during February to April, 1920. Owing to the lack of adequate funds, however, it has been necessary to defer the establishment of stations on the Pacific and Gulf coasts, where they are urgently needed.

The few measurements obtained indicate that during the spring months, at least, solar radiation near sea level in the Pacific Coast States has about the same intensity as in the Plains States.

Measurements of the intensity of the heat radiated from different types of orchard heaters and of the retardation of nocturnal cooling by a smoke cover were made during the winter of 1919-20 in orchards in California and Oregon. The results, which were published in the Review for June, 1920, indicate that to protect orchards from frost the attempt should be made to warm the air by the total combustion of fuel rather than to retard cooling by the production of a smudge through the imperfect combustion of fuel.

A study of the relation between the solar constant values published by the Smithsonian Institution and the weather conditions in the United States was well under way at the end of the year. It promises interesting developments in the subject of temperature control.

## REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF ANIMAL INDUSTRY,  
Washington, D. C., October 13, 1920.

SIR: I have the honor to transmit herewith a report of the operations of the Bureau of Animal Industry for the fiscal year ended June 30, 1920.

Respectfully,

JOHN R. MOHLER,  
*Chief of Bureau.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### ACTIVITIES RECEIVING SPECIAL ATTENTION.

#### NOTEWORTHY INCREASE IN ACCREDITED HERDS.

Conspicuous among the efforts to suppress and eradicate animal diseases during the year has been the excellent progress in tuberculosis eradication. The accredited-herd plan, under which herds of cattle passing a series of official tests receive appropriate recognition, has met with general support from livestock owners and State sanitary officials. During the fiscal year ended June 30, 1920, altogether 695,364 cattle were tested. Of these, 28,616 reacted and were removed. The number of accredited herds at the end of the year was approximately three times as large as on June 30, 1919. The records show also that in addition to fully accredited herds, 16,599 other herds containing 257,577 cattle have passed the first official test, no reactors being found. Public interest in accredited-herd activities and the enthusiasm with which cattle owners are cooperating are shown by the number of applications for testing. The waiting list at times has included nearly 5,000 herds.

To meet as fully as possible the demand for testing, the bureau has modified some of the earlier features of the campaign. It has recognized under prescribed conditions the intradermic test in addition to the subcutaneous, which in the past has been the one principally used, and has obtained evidence also that the ophthalmic test, now frequently used as a check on the others, is dependable when applied by veterinarians skilled in its use.

A noteworthy development in tuberculosis eradication is the tendency to free from the disease areas containing many farms. During the year Clay County, Miss., Island County, Wash., and Clatsop

County, Oreg., made complete tuberculin tests of all cattle within their boundaries. The eradication of tuberculosis should proceed more rapidly even than in the past when it is taken up on the area basis with such beginnings as the three counties mentioned have made.

The feasibility of not only freeing a region from tuberculosis but keeping it free is shown by the continuance of tuberculin testing in the District of Columbia. Bureau veterinarians tested during the year 1,173 cattle in the District, among which were found 3 reactors. These animals, however, had been brought into the District on a health certificate. In addition to animals within the District which were tested, 425 head were tested for entry, among which 18 animals proved to be reactors and were excluded.

Investigations of tuberculosis among swine continue to show that swine are infected principally by cattle.

#### HOG-CHOLERA CONTROL.

Reports of the Meat Inspection Division continue to show that next to tuberculosis hog cholera is the principal disease for which carcasses and parts were condemned. The bureau cooperated with 34 States in investigating reported outbreaks of hog cholera, administering treatment, preventing the disease from spreading, and stamping out the contagion by approved methods of cleaning and disinfecting premises, pens, and yards where cholera-sick hogs had been held. In addition bureau veterinarians conducted demonstrations, assisted veterinary practitioners in improving their technique, and conducted general educational work. During the greater part of the year 140 veterinarians devoted their time to the control of hog cholera, but in the last quarter, when it became evident that such activities would be curtailed during the fiscal year 1921 owing to lack of funds, the number of veterinarians was reduced. Likewise it became necessary to reduce the educational part of the work.

#### TICK-INFESTED AREA IS SMALLER.

During the year areas aggregating 50,555 square miles, formerly infested with cattle-fever ticks, were released from Federal quarantine. The total area freed from ticks since the beginning of the work in 1906 is 509,084 square miles, or 70 per cent of the area originally infested. The work is progressing also in additional territory. Following the eradication of cattle-fever ticks well-bred stock may be safely introduced; in fact, regions of the South now removed from quarantine are raising and marketing excellent cattle.

Progress in the control of other diseases and in investigations relating to practical methods of prevention are included in reports of various divisions.

#### DANGER FROM FOOT-AND-MOUTH DISEASE.

Apparently there never was a time when the United States was more dangerously exposed to invasions of foreign animal diseases than at present. European countries were unable to give the usual attention to the suppression of infectious diseases of animals during the recent



war, and as a result there has been an increase and some of them have become widespread. One of the most infectious and destructive of these plagues is foot-and-mouth disease. England has been fighting it during the last 18 months; Holland has been unable to keep it under control even with the application of the most drastic measures; and discouraging reports have reached the bureau from France, Italy, South America, and other foreign countries.

The existence of foot-and-mouth disease in foreign countries has been a constant menace to the livestock industry of our country, owing to the readiness with which the virus may be carried in the bodies of animals, in hides, and in other livestock products; but our danger has become greater of late on account of the increased prevalence and virulence of the disease in Europe.

Although the United States has been free from foot-and-mouth disease since early in 1916 and every reasonable precaution is being taken to prevent its introduction, we should be prepared in every way possible promptly and effectually to eradicate an outbreak should it occur. The various States have been urged repeatedly to provide funds and to perfect organizations to cooperate with the bureau should the disease reappear in this country.

The progress of our foot-and-mouth disease eradication work in the past outbreaks has been hampered through a lack of sufficient funds to fulfill promptly our responsibility. The necessity for prompt action in eradicating centers of infection indicates the need for an adequate reserve fund available for immediate use.

For several years past each Congress provided \$1,000,000 specifically for combating foot-and-mouth disease. As there were no outbreaks, the appropriation reverted to the Treasury at the end of each fiscal year. This appropriation was reduced by the last Congress to \$50,000, which is insignificant for coping with a serious outbreak. A more liberal sum is needed as an insurance fund to be used in case of emergency. In view of the immense value of our livestock, the related interests involved, and the prevalence of the disease in foreign countries with which we carry on an extensive commerce, the bureau should be provided with an immediately available fund of at least \$1,500,000 for use in suppressing foot-and-mouth disease should we be so unfortunate as to have another outbreak.

#### IMPROVING QUALITY OF LIVESTOCK.

The importance of a better quality of livestock has become evident in connection with high costs of feed, labor, and other production factors. That there is widespread public interest in livestock improvement is shown by the support which such activities as cow-testing associations, poultry culling, and the "Better Sires—Better Stock" movement are receiving. On June 30, 1920, cow-testing associations in the United States numbered 467, a gain of 85 over the corresponding date in 1919. Bull associations increased in number during the same period from 78 to 120.

The "Better Sires—Better Stock" campaign, planned to bring about improvement in the average quality of all classes of livestock, has been well received. On June 30, 1920, 2,078 persons, owning approximately 232,322 head of stock had pledged themselves to use

only purebred sires and to follow methods of breeding leading to livestock improvement. The agricultural press made liberal use of news material and educational articles relating to the practical benefits following the use of purebred sires. Statistical information compiled from blanks filled out by persons participating in the campaign shows clearly that purebred sires lead to rapid improvement of female stock likewise.

Much progress has been made in methods of feeding and management, but economical production also requires careful selection and constructive breeding. Livestock men are much concerned regarding foreign competition, but with well-bred farm animals of all kinds the farmers of this country can best meet such competition. Many of our dairy cows, even when well fed, lack the ability to produce milk economically, and many steers and hogs require altogether too much grain to produce a pound of meat. Comprehensive investigations are now under way to learn definitely the principles of breeding that will make possible the most economical production.

#### ESTABLISHING NEW BREEDS OF LIVESTOCK.

Success has followed efforts of the bureau to develop types of livestock believed to be more useful than those now represented by present breeds. Range-sheep breeding conducted in Clark County, Idaho, is resulting in a type which has become so fixed as to warrant its classification as a breed. These sheep, known as Columbia sheep, are particularly adapted for range conditions and are believed to be profitable both for mutton and for wool production.

A new type of American utility horse is rapidly being established in cooperation with the State of Wyoming at Buffalo, Wyo. Characteristics of the type, possibly entitled to the term "breed," are activity, strength, endurance, and reasonable speed. The horses are believed to meet a demand for general farm and ranch work, delivery purposes, and for certain classes of military service.

Poultry breeding at the bureau farm, Beltsville, Md., shows progress in the establishment of a new breed of fowl. Certain characteristics, such as white plumage and yellow legs and skin, are now well fixed, but there is still considerable variation in type and in color of eggs. The birds developed this year show improvement over those of a year ago.

#### EXPORTS OF PUREBRED LIVESTOCK.

The increasing prominence of the United States as a source of purebred livestock for other countries has resulted in bureau activities planned to encourage such exportations. A representative of the bureau was detailed for service in South America to acquaint livestock owners there with types of American animals and to study conditions. The bureau has also assisted foreign purchasers of stock to obtain in this country the breeds and types desired. In May, 1920, the bureau sold a Morgan stallion, mare, and colt to Japan. This is one of the first shipments of Morgan horses to that country.

#### SOFT-PORK INVESTIGATIONS.

In swine husbandry a new and important investigation relates to the cause of soft pork often noted in southern hogs fed largely on

peanuts. The study of soft pork includes experiments in feeding in cooperation with southern experiment stations, the slaughter of the animals at the bureau farm, Beltsville, Md., and various laboratory tests of the meat and fat.

#### EXTENSION ACTIVITIES.

Native ewes bred to purebred rams at the Mississippi Coastal Plain Experiment Station resulted in lambs which when 6 months old outweighed their dams and yielded more than twice as much wool.

Boys' and girls' poultry clubs have brought about increased quality of fowls bred and raised by the members. Frequently club members have exhibited their fowls and obtained prizes in competition with more experienced breeders.

#### DAIRY ACTIVITIES.

Dairy-extension work has introduced successfully methods of cheesemaking developed in the bureau. In the South, particularly in North Carolina and Tennessee, the cheese industry is becoming a noteworthy factor in dairying. In each of these States two new factories were established during the year with the help of Dairy Division specialists. The Grove City Creamery, Grove City, Pa., conducted under the direction of the Dairy Division, continues to manufacture foreign types of cheese made by methods developed in the laboratory of that division. The production of Roquefort, Swiss, and Camembert cheese during the year exceeded 130,000 pounds.

The prevalence of milking machines on dairy farms of the country has resulted in a demand for information on best methods of cleaning and sterilizing such equipment. In tests conducted on Virginia and Maryland farms the heat method gave somewhat better results than disinfecting solutions.

#### MEAT INSPECTION REFLECTS LIVESTOCK CONDITIONS.

In addition to its regulatory activities, the Federal meat-inspection service furnishes information that reflects current conditions in the livestock industry. The various ailments, diseases, and conditions for which animals and parts were condemned are indisputable evidence of the relative prevalence of diseases. During the fiscal year inspection figures showed a decrease in the total number of animals slaughtered, in the quantity of meats processed, and in the amount of meat and product certified for export. This information corroborates other findings of the bureau, pointing to somewhat decreased domestic consumption of meats. During the year provision was made for the inspection of horses and horse meat, and 1,093 horses were federally inspected. A very large proportion of the horse meat passed for food is exported.

#### RECOMMENDATIONS.

As to the more urgent needs for protecting the livestock industry of the Nation, the following recommendations are made:

That the present work on the eradication of scabies from sheep and cattle be kept up and somewhat expanded in order not to lose



the advantages gained in previous years, and that a larger sum be devoted to the supervision of the interstate transportation of live-stock, as shipments are constantly increasing and should continue to be closely watched.

It is further recommended that a considerably larger appropriation be made for the eradication of tuberculosis. This great project has been received with enthusiasm throughout the country, and much larger Federal funds will be necessary in order to keep pace with the liberal expenditures of the States.

An increase of approximately \$175,000 for dairy work should by all means be granted. The country has two billion dollars' worth of dairy cattle, and consumers annually pay four billion dollars for dairy products. Certainly the Federal funds for increasing the efficiency of production and for better utilization of by-products should be liberal.

An increase of a similar sum is urgently needed in the animal-husbandry projects. Beef production is at a critical period, and help on the part of the department is essential. The bureau sheep range in Idaho has reached a point where a material increase for expenditures for a few years will enable the department to reach conclusions of great value. An extension of the bureau's poultry work also is necessary in order to meet the urgent calls from States for help in solving poultry problems and in the organization of poultry clubs.

Small increases are also recommended in the appropriations for investigations of animal diseases, especially for the study of internal parasites of hogs and parasites of southern livestock. After territory is freed of cattle ticks and livestock raising becomes a great industry in the South it is essential that the parasitic infections of the new areas be thoroughly understood. It is especially urged that funds for the eradication of hog cholera be so increased as to provide the same amount of money as was available before this fiscal year. The great extent of this industry, and the large reduction in losses directly attributable to the bureau's efforts heretofore, offer an unanswerable argument for continuing this work at its former level.

Inasmuch as there has been no construction at the Beltsville farm for three years, it is necessary that a somewhat larger sum now be devoted to this purpose. The numbers of animals have been increasing and the experimental projects have so grown that additional buildings must be provided.

A small item should be included also to cover the campaign for better sires and better stock, which has proved so successful and popular.

An increase of approximately \$300,000 is recommended for meat inspection, a sum which will cover the steady growth of this service and will provide for increases in salary for a portion of the 2,500 employees.

In conclusion, at the risk of repetition, I strongly recommend that the insurance fund of \$1,000,000 carried in the appropriation until this year, for use should an outbreak of foot-and-mouth disease, rinderpest, or other animal scourge occur, be restored to the law. As has been explained so often, this is not an appropriation of money but merely the making available of a sum to be used only in the event of an outbreak of any of the Old World destructive diseases

which are at present ravaging the livestock of many foreign countries. It is an assurance that the department will be able to take the most prompt and vigorous action immediately should the necessity arise.

#### LITERATURE.

During the year 67 new publications were issued or contributed by the bureau. These included 10 Farmers' Bulletins, 4 Department Bulletins, 2 contributions to the department Yearbook, 13 issues of Service and Regulatory Announcements, 3 articles for the Journal of Agricultural Research, 16 Department Circulars, 3 miscellaneous pamphlets, 6 orders in the nature of regulations, and 3 posters. In addition 323 articles relating to the work of the bureau were published.

#### REPORTS BY DIVISIONS.

The year's work as conducted by the various divisions of the bureau is presented more fully in the following pages.

#### ANIMAL HUSBANDRY DIVISION.

The work of the Animal Husbandry Division, under George M. Rommel, chief, has undergone some reorganization and readjustment in the cessation of war-emergency activities, the curtailment of extension work from lack of funds, and the transfer of some of the horse-breeding work to the War Department. The research activities, however, have been continued with good progress.

#### SAVING ANIMALS FROM DROUGHT-STRICKEN AREAS.

A severe drought in Montana and adjoining States in the summer of 1919 necessitated relief work to save much of the livestock of that area from starvation or premature slaughter. This work was begun in July, 1919, under the direction of a committee of department officers, of which the Chief of the Animal Husbandry Division was chairman. A considerable force of department employees spent several months in this service, and other Government agencies cooperated. At least 300,000 cattle and between 500,000 and 600,000 sheep were moved out of the drought area to other sections, where feed and pasture were available. This work was reviewed in some detail in the department's Yearbook for 1919.

#### BEEF-CATTLE INVESTIGATIONS.

##### BEEF PRODUCTION.

Experimental work in breeding and feeding beef cattle has been continued in Mississippi, North Carolina, West Virginia, Kansas, and Arkansas, in cooperation with State agricultural experiment stations. The steer-feeding experiment at the Animal Husbandry Farm, Beltsville, Md., to determine the comparative feeding value of velvet beans and cottonseed meal for fattening steers, has been transferred to the Coastal Plain Experiment Station at McNeill, Miss.

Experiments to determine the most desirable rations and methods for wintering steers were continued at Lewisburg, W. Va. Sixty

2-year-old steers, averaging 927 pounds in weight, were divided into 6 lots of 10 steers each and wintered for a period of 128 days beginning December 23, 1919. The greatest gain—93 pounds—was made by the lot fed on a daily ration of 25 pounds of silage, 5.4 pounds of straw, and 1 pound of cottonseed meal. Other rations and gains were: Silage (40 pounds), gain, 79 pounds; silage (30 pounds) and cottonseed meal ( $1\frac{1}{2}$  pounds), gain, 67 pounds; silage (25 pounds) and mixed hay (8 pounds), gain, 63 pounds; mixed hay (20 pounds) and ear corn (2 pounds), gain, 25 pounds; silage (30 pounds), gain, 22 pounds.

The steers used in wintering experiments at Lewisburg were grazed on pasture to determine what effect the different rations fed and methods of wintering had on subsequent pasture gains. This experiment had not been completed at the close of the fiscal year. A series of three years' cattle-feeding experiments at Lewisburg was completed in the fall of 1919 and the results were prepared for publication as Department Bulletin 870. Another series of three years' experiments at Springdale, N. C., was likewise finished, and the results are being prepared for publication. Experimental work at the latter station has been temporarily discontinued.

A study was made of the problems of beef-cattle production on the ranges of Florida. The location of the studies was in Palm Beach County. The more important results may be stated briefly as follows: Approximately  $12\frac{1}{2}$  acres appear to be required to carry an animal through the year in that section; a calf crop of 50 to 60 per cent may be expected annually; rapid improvement of the native stock can be made by the use of purebred bulls; the mortality is no higher on these ranges than on the western ranges; the use of nitrogenous concentrates in connection with winter grazing offers the most practicable solution of the winter-feeding problem; utilization of the native grasses with the object of gradually improving the pastures may be considered one of the chief problems. It appears that the ranges can best be utilized in units of considerable size; 10,000 acres has been taken as a convenient unit on which to base estimates. There is great need for further investigational work on range problems in connection with large operations, not only in Florida but in the entire Coastal Plain area.

Considerable attention was devoted also to range-cattle problems in the West.

Investigations pertaining to fattening beef cattle in Illinois, Indiana, Iowa, Missouri, and Nebraska are being conducted in cooperation with the Office of Farm Management and the State experiment stations.

Experiments in cattle breeding are being carried on at Manhattan, Kans.; Jonesboro, Ark.; and McNeill, Miss. The 20-year breeding experiment in the development and transmission of the milking tendency in beef cattle, conducted in cooperation with the Kansas Agricultural Experiment Station, is being continued. One of the main objects is to determine whether it is possible to retain the typical beef form in the male animals and at the same time increase the milking tendency in the females. Careful records are being kept of the milk production of the cows originally selected, and as rapidly as possible these original cows are being replaced by their daughters



that are of the right type and also heavy milkers. So far, 8 daughters of the original cows have been officially entered in the experiment. Steer calves out of these cows have been shown at the International Livestock Exposition at Chicago and at other shows, where they have been consistent winners. One was first-prize junior yearling steer at the 1919 International. The experiment has not progressed far enough to make any deductions.

In July, 1919, experiments in producing purebred beef cattle were begun in cooperation with the Arkansas Agricultural Experiment Station at the Jonesboro agricultural school. Herds of purebred Shorthorn, Hereford, and Aberdeen Angus cows with desirable herd bulls were purchased. Rations and methods of wintering, summer grazing, growing beef calves, and preparation for show or sale are being studied in connection with the production of purebred beef cattle.

Progress was made in equipping and stocking the newly established experiment station at McNeill, Miss., where experimental work with beef cattle is being carried on in cooperation with the State experiment station. A breeding herd of 50 grade and native cows was purchased for experiments in grading up by the use of a purebred bull. Data obtained on the carrying capacity of carpet-grass pasture and the gains made by cattle indicate the high value of this grass. Forty acres of carpet-grass pasture on very poor land carried 28 head of cattle and 60 head of sheep over a period of nine months. Mature breeding cows showed a gain of 100 pounds per head during this period. The propagation of carpet-grass pastures is being undertaken as a major project at this station. Cows which were "roughed" through the winter with a small allowance of cottonseed meal in addition to grazing, according to the common method of that section, showed a heavy loss in weight and were in poor condition to suckle calves in the spring.

At the McNeill station three lots of steers were fattened for market on the following ration: (1) Cottonseed meal and silage, (2) dry velvet beans in the pod and silage, (3) soaked velvet beans in the pod and silage. The average daily gains were, respectively, 2.1, 2.8, and 2.4 pounds. In the face of adverse market conditions all lots returned good profits. Velvet beans at the rate of 2 pounds for each pound of cottonseed meal reduced the silage consumed by 10 pounds a day and made cheaper and more rapid gains and a better finish. This experiment confirms previous results as to the value of velvet beans as a cattle feed.

#### BEEF-CATTLE EXTENSION.

Beef-cattle extension work was carried on in cooperation with the State agricultural colleges and the county agents. The work of the beef-cattle extension specialists has been especially effective during the last few years in stimulating the industry to meet the demand for greater production under adverse conditions and has been the means of unifying the best methods throughout the country. During the last year the specialists gave 158 demonstrations in feeding, herd management, pasture management, dehorning, silo construction, judging cattle, fitting them for sale, etc. They also cooperated in the "Better Sires" campaign to eliminate the scrub and other unde-

sirable sires. Their efforts are beginning to show remarkable results in many herds where purebred sires have replaced the inferior ones formerly used. During the last year they were instrumental in the purchase by farmers of 338 purebred bulls and 413 purebred cows. A large number of cooperative breeders' sales of purebred cattle were conducted under the direction and supervision of the specialists. They also aided in the organization of a large number of livestock associations, with a total of 2,000 members, held 191 meetings and lecture courses, with an attendance of 16,739, and gave specific instruction to 954 farmers on their farms. This work was discontinued entirely on June 30, 1920, when the appropriation under which it had been conducted lapsed.

#### SWINE INVESTIGATIONS.

The breeding herd of hogs at the bureau's experiment farm at Beltsville, Md., consisting of purebred animals of the Duroc-Jersey, Poland China, Hampshire, Chester White, Berkshire, and Tamworth breeds, last spring numbered 57 brood sows and 9 boars. The pigs are used in experimental work.

The third experiment in the series to determine the effect of lice on the fattening of pigs was completed. Fifteen pigs infested with lice and 15 without lice were kept under similar conditions for 89 days. The former made an average daily gain of 1.28 pounds and the latter 1.59 pounds. The feed cost per pound of gain was 15.2 cents for the former and 12.3 cents for the latter.

An exhibit of cured pork was prepared at the Beltsville farm for showing at fairs. Products from the Beltsville experimental abattoir yielded \$7,095.10, which was paid into the United States Treasury.

#### FEEDING FISHERY BY-PRODUCTS.

Experiments in the use of fish meal and other fish-factory by-products as a protein feed for swine were continued, in cooperation with the Bureau of Fisheries of the Department of Commerce and the Bureau of Chemistry of this department. Feeding tests were made with meal from menhaden and from grayfish, and also with fish meal with varying contents of oil and differing in other ways. The feeding value of these materials was confirmed, and no disagreeable flavor or odor could be detected in the meat of the hogs to which they were fed. Manufacturers have been encouraged to prepare the products in such manner that they could be recommended to hog feeders, and efforts have been made to acquaint feeders with the merits of fish meal as a protein concentrate and as a supplement to corn.

Shrimp waste, known also as shrimp bran, from the lower Atlantic and Gulf coast shrimp-packing industry, while lower in protein and having a less valuable mineral content than fish meal, has proved also to be a valuable addition to the list of available hog feeds.

#### SOFT-PORK INVESTIGATIONS.

A study of the problem of soft pork in the Southern States was begun under a special appropriation by Congress. Much of the work

has been of a preliminary character in organizing the investigations. Cooperation is being received from the Southern Agricultural Workers' Association, agricultural experiment stations of the Southern States, the National Swine Growers' Association, and the Institute of American Meat Packers. Three hundred and eighteen hogs fed experimentally at the Alabama, North Carolina, Georgia, Mississippi, and Texas stations have been shipped to Beltsville for slaughter and their meat examined. All were classed as firm except those that had been fed on peanuts and some that were immature.

#### SWINE-HUSBANDRY EXTENSION.

During the last year the swine-extension work has been carried on with the idea of teaching the farmers better and more economical methods of production rather than making a drive for increased production, as was done during the war period. Farm demonstrations were the principal means employed. The usual procedure was to arrange with a farmer in a community to grow and feed a suitable forage crop, or feed a balanced ration, or otherwise manage his herd according to recommendations of the extension specialist, and keep satisfactory records. At intervals and especially at the close of the demonstration the neighboring farmers were invited to meet at the demonstrator's farm, and the specialist led a discussion of the practices and results. Various problems of hog raising were also considered at these meetings.

The killing and curing demonstrations have been very favorably received. A hog is killed one day and cut up and the meat put in cure the next day. The methods of curing are explained and the causes of failures discussed. In most cases the demonstration is in cooperation with the home demonstration agent, who cans some of the meat and assists in making sausage, headcheese, etc. The serving of sausage adds interest to the occasion.

Twenty-three field men working in 17 States were employed in swine-extension activities during the year. They visited 636 counties and gave 467 lectures before audiences totaling 48,172 persons. They organized 476 demonstrations, visited 1,196 farms, and aided farmers in procuring 579 purebred sows and 156 purebred boars.

#### SHEEP AND GOAT INVESTIGATIONS.

##### FARM-SHEEP INVESTIGATIONS.

Experimental work with farm sheep was continued at the bureau's farms at Beltsville, Md., and Middlebury, Vt. The experiments at Beltsville consisted of a study of specialized sheep farming in which forage crops were used for the summer pasture, and a study of the relation of nutrition of ewes at breeding time to the percentage of lambs produced. Data were obtained relative to the comparative relish with which sheep ate different forage crops and the gains made while pasturing upon them. It was demonstrated that with the frequent rotation necessary in pasturing forage crops, sheep could be successfully raised without danger of infestation by stomach worms or other internal parasites. Experiments in the last four years to test the effect of feed at breeding time upon the size of the lamb crop have



shown an increase of 18.8 per cent of lambs produced by increased nutrition of ewes during mating season, for both Beltsville and Middlebury. This is an increase of 25.9 per cent in the Beltsville flock and 8.55 per cent in the Middlebury flock.

In experiments with 120 western ewes at the Middlebury farm to test the effect of running sheep in permanent pasture upon the growth of weeds, and the carrying capacity of the fields, it has been demonstrated that sheep are beneficial in cleaning pastures of weeds, but that it must be accomplished gradually and should not be overemphasized as a reason for engaging in sheep raising.

The results of the foregoing work are embodied in two papers prepared for publication.

#### RANGE-SHEEP INVESTIGATIONS.

The work with range sheep at the Government sheep experiment station in Dubois, Idaho, is yielding very gratifying results, especially in the development of a true-breeding type of sheep, suited to range conditions, from the Lincoln-Rambouillet cross. In the five years during which this work has been under way the desired type has been quite definitely fixed. This has been accomplished in much less time than would have been possible by usual breeding methods. Instead of going back to one or the other of the parent breeds, the crossbred progeny were interbred in each succeeding generation. It is believed that this is the first time that an attempt has been made to establish a breed of the larger animals by such methods. The name "Columbia" has been adopted for these sheep. The value of the experiment is expected to come not through the distribution and use of the Columbia sheep but rather by demonstrating what can be accomplished by breeding methods similar to those used in this project.

Other investigations at the sheep experiment station are the comparison of Rambouillet sheep with crossbreds and the study of the suitability of Corriedale sheep to range conditions.

The receipts from the station for the year were \$15,811.84, of which \$9,477.84 was cash turned in to the United States Treasury, the balance being represented by exchanges for other animals as authorized by Congress. The coarse wool for 1919 was still on hand at the close of the fiscal year, and 375 yearling ewes were added to the flock. A conservative estimate would place the value of the products from the station for the year at \$25,000.

#### FARM-SHEEP DEMONSTRATIONS.

The demonstration and extension work relative to farm sheep was carried on by bureau specialists in 17 States in cooperation with the college extension forces and county agents. This has included demonstrations in sheep management, including docking, castration, shearing, culling, and treatment for parasites, as well as the introduction of better breeding stock, the promotion of boys' and girls' clubs, assistance in the organization of farmers' cooperative wool pools, instruction in grading wool and preparing it for market, and encouraging the larger consumption of lamb in the diet. The specialists gave 776 lectures before audiences aggregating 42,916 persons,

aided in forming 102 organizations with 1,538 members, gave 691 demonstrations attended by 17,716 persons, visited 1,916 farms, and were instrumental in placing 800 purebred rams.

#### MILK-GOAT INVESTIGATIONS.

The experiment begun in 1911 in grading up from native and grade Toggenburg and Saanen does with purebred Swiss bucks was continued. The flock comprises 26 does and 8 kids of one-half, three-fourths, seven-eighths, and fifteen-sixteenths blood. The average daily milk yield per doe in 1919 was 3.92 pounds, an increase of 2.42 pounds over the yield of the 10 selected native does which formed the foundation stock of the herd. The highest milk yield for an individual doe in one day is 8.6 pounds. For 1919 the flock showed an average of 3.7 per cent butterfat.

#### HORSE AND MULE INVESTIGATIONS.

##### BREEDING AMERICAN UTILITY HORSES.

In the work for the development of a breed of active utility horses for general farm and ranch work, conducted in cooperation with the State of Wyoming at Buffalo, Wyo., there were in the stud at the close of the fiscal year 13 stallions, 24 mares, 4 yearling colts, 2 yearling fillies, and 9 foals, a total of 52 animals. Seven of the stallions were leased for the 1920 breeding season.

##### BREEDING MORGAN HORSES.

The breeding of Morgan horses at the Government Morgan Horse Farm, Middlebury, Vt., continues to progress very satisfactorily. A very uniform lot of foals are being sired by Troubadour of Willowmoor, the stallion now at the head of the stud. At the end of the fiscal year there were on the farm 6 mature stallions, 7 young stallions, 33 mares and fillies, 7 geldings, and 14 foals, a total of 67 animals. Three of the stallions were leased for the 1920 breeding season. The young animals have grown well and promise to develop into high-class animals.

In May the stallion Donlyn and the mare Jewel and her colt by Troubadour of Willowmoor were sold for shipment to Japan.

##### BREEDING HORSES ON INDIAN RESERVATIONS.

During the 1919 breeding season 735 mares were bred to the 12 stallions (2 Standardbred, 2 Saddle, and 8 Percheron) maintained under the project for breeding horses on Indian reservations, with headquarters at Eagle Butte, S. Dak. Up to June 30 in the 1920 breeding season 202 mares were bred to 9 stallions. Because of lack of funds it was necessary to withdraw from this cooperative work with the Indian Office at the close of the fiscal year.

##### BREEDING HORSES FOR MILITARY PURPOSES.

The plan of breeding horses for military purposes was changed this year by eliminating the free-service feature and the agreements

whereby the Government had been given options on the foals. For the 1920 breeding season a service fee is charged, and the owners of the mares have been given the privilege of making whatever disposition of the foals they may wish. In the second district, with headquarters at Front Royal, Va., 12 stallions were used, and 333 mares were bred to them up to June 30. In the third district, with headquarters at Lexington, Ky., 12 stallions were used, to which 364 mares were bred up to June 30. In the first district, with headquarters at Middlebury, Vt., the breeding season did not begin until about June 1.

Congress having made provision in the Army reorganization act for the Army to take up the breeding of horses for military purposes, the bureau's work in the second and third districts will be transferred to the Army; but as the Army does not contemplate breeding Morgan horses, the bureau's work in the first district will be continued during the next fiscal year.

#### FEEDING BARLEY TO FARM WORK HORSES.

A test to compare the relative value of light-weight and heavy-weight barley as feeds for farm work horses was made at the Beltsville farm. Eight Percheron mares were used in the test, two receiving light-weight barley, two heavy-weight barley, and four receiving oats as a check. The test was continued 22 weeks, terminating June 19, 1920. The mares were used in all the routine work of the farm, which included the heavy field work of plowing, etc., during the spring months. The barley used was the commercial grade of heavy barley (rolled) and light barley (rolled), the heavy barley weighing 50 and the light  $37\frac{1}{2}$  pounds to the bushel. The relative gains or losses in weights of the mares fed on barley and those fed on oats were practically the same, and there was no indication that either feed possessed outstanding merit over the other. The weights of the mares fed on light barley remained more constant than the weights of the mares fed on heavy barley, and the former seemed to be slightly more thrifty than the latter, although the advantage seemed slight.

#### POULTRY INVESTIGATIONS.

##### POULTRY FEEDING.

In the poultry-feeding experiments much of the work previously done is being repeated to verify former results. This includes the feeding of rations containing wheat products compared with a wheatless ration, the feeding of garbage, and experiments in the use of high vegetable protein feeds, including soy-bean meal, peanut meal, velvet-bean meal, and cottonseed meal.

The results with wheat have confirmed previous tests showing that just as good results can be obtained without wheat as with it in a ration. The Rhode Island Reds in the wheatless pen averaged 140 eggs, while those in the pen receiving wheat averaged 134 eggs. Good results were obtained with the use of garbage last year until the hot weather began, when there was considerable mortality, due apparently to the garbage spoiling. This work is being repeated this year with much more satisfactory results, the garbage being fed in a



trough on a large wooden feeding board, which prevents it from getting on the ground and decaying. In the use of vegetable proteins the relative order of production is the same as it was last year. No success has followed an attempt to substitute completely vegetable protein for animal protein. The ration used last year, a mash containing only 15 per cent meat scrap as compared with 20 to 25 per cent in the ordinary mashes, gave very satisfactory results with the heavier breeds, especially the Plymouth Rocks, in keeping the birds in good physical condition and fertility, though the egg yield was not quite so good as when the higher per cent of meat scrap was used.

New experiments were begun this year with green feeds, comparing alfalfa meal with sprouted oats and comparing these rations with one in which vegetables were supplied. While none of these green feeds have shown marked increased production over any other, the results have emphasized the importance and value of some form of green feed and also of a variety of these feeds. Experiments in feeding moist and dry mash, begun this year, have given considerably increased yields for the moist mash, but some difficulty has been experienced in getting the ordinary laborer to handle the feeding of moist mash satisfactorily, while with the dry mash there is very little chance for a laborer to go wrong.

The highest egg production this year has been obtained from a pen receiving a mash composed of 4 pounds bran, 4 pounds middlings, 26 pounds meat scrap, and 66 pounds corn meal. This ration has been one of our best mashes, giving consistent high production over a period of several years, and is not markedly different from the mash used in the wheatless ration, which has also given very good production.

A Farmers' Bulletin, on the results of all the feeding tests with laying hens, published last year, has had a very extensive circulation.

#### POULTRY BREEDING.

This year approximately 1,500 hens are being trap-nested. In the spring of 1920 more than 4,000 chicks were pedigree-hatched and banded. The breeds used in greatest numbers are the Single Comb White Leghorn, the Single Comb Rhode Island Red, the Barred Plymouth Rock, and the new breed which is being established at the farm. In addition there are smaller numbers of White Plymouth Rocks, Buff Orpingtons, Single Comb Buff Leghorns, Silver Spangled Hamburgs, Black Hamburgs, and Dark Brahmas. Last spring a small start from the purchase of hatching eggs was made with the Light Brahma and the Dark Cornish.

The object of the general breeding work is to produce birds equal to any in quality and to bring about improvement in the egg-producing ability of the stock as well. The principal effort, therefore, has been centered in attempting to obtain these two qualities in the same birds. Progress is being made in this difficult problem, especially with the Single Comb White Leghorns and the Rhode Island Reds. Birds of both of these breeds were exhibited last winter at the Boston Poultry Show and at the Madison Square Garden Poultry Show in New York, and caused a great deal of favorable comment, not only from visitors but in the poultry press.

The work of establishing a new breed is progressing satisfactorily. The white plumage and yellow legs and skin are now well established. The four toes are also quite firmly established, as less than 5 per cent of the chicks show five toes. The ear lobe is not yet definitely fixed, although close to 50 per cent of the birds of this year's hatch show solid red lobes. There is still a considerable variation in type, but greater uniformity is shown each year.

In the experiments in grading up mongrel flocks by the continued use of purebred males the fourth generation has been produced. The Barred Plymouth Rock grades all show good uniform Barred Rock color and are quite uniform in type. The White Plymouth Rock grades do not all show pure white, although a large proportion of them show typical White Plymouth Rock type and color. A gain of more than 2 pounds a head over the original mongrel weight has been obtained.

#### PRESERVING EGGS.

Experiments in preserving eggs have been conducted in the last two years, testing different strength solutions of water glass, limewater, and various commercial preparations. The best and most economical results have been obtained by using 1 part of water glass to 9 parts of water. Just as good results have been obtained with limewater as with water glass, and in many sections limewater is much less expensive. When salt was used with the limewater the results were about the same as without the salt, showing no advantage in using salt. None of the commercial preparations, all of which called for smearing the eggs with the preparation, gave results that were at all satisfactory. When the water-glass and limewater solutions were kept over and used again for the second year the eggs kept comparatively well, but not so well as in fresh solution. In most cases the old solutions were not in good enough condition to use again after they had been kept one year. Under usual conditions it does not appear advisable to use the water-glass or limewater solution again for the second year.

In testing containers the best results were obtained with stone crocks, but the water-glass solution was perfectly satisfactory in well-galvanized receptacles, such as garbage cans or ash cans. Limewater corroded the galvanized receptacles and gave satisfactory results only in the earthenware crocks. Wooden kegs and other wooden containers did not give satisfactory results with any of the solutions.

The interest in preserving eggs has been very marked during the last two years, and a very large number of leaflets giving directions for preserving eggs have been distributed, indicating that a great many families are preserving eggs for home use to help keep down the cost of living.

#### SOUTHWESTERN POULTRY INVESTIGATIONS.

The work with ostriches at the branch experiment station at Glendale, Ariz., has been continued, but on account of the limited interest in ostrich-feather production this work has not been extended.

Trap-nest and pedigree work with chickens is being carried on at Glendale with stock from Beltsville. Information on the hatching.

brooding, and rearing of chickens under Arizona conditions is also being obtained in this work.

#### POULTRY EXTENSION.

Activities in poultry husbandry extension during the last year have been almost entirely confined to the poultry-club work. The demand for literature on the production of infertile eggs, early hatching, and culling has continued, and large numbers of our pamphlets dealing with these subjects have been distributed. Most of the State agricultural colleges have now taken up these lines of work.

#### POULTRY CLUBS.

Supervision of boys' and girls' poultry clubs, in cooperation with State agricultural colleges, was continued in seven States, where there were 1,186 clubs with 29,480 members, of whom 12,786 made reports from which the following totals have been compiled: Eggs set, 731,709; chicks hatched, 510,478; value of products sold, \$94,791.32; value of stock on hand \$382,277.37; exhibits held, 712; members exhibiting, 5,615; prizes received, \$9,681.11. A feature of progress was the improvement in quality of fowls bred by club members. In numerous instances the boys and girls won prizes in open competition with older and established breeders.

#### PIGEON AND SQUAB INVESTIGATIONS.

Experimental work with pigeons has consisted in the breeding of squabs, keeping records of breeds for squab production, and breeding and training homing pigeons. The loft of homing pigeons at the Beltsville farm contains about 250 birds. Some of them were entered in the southern pigeon races in the fall of 1919 and in the western races in the spring of 1920. They took several first places in both and made the best average speed in the former series.

#### ANIMAL GENETICS.

In the work in animal genetics the effects of inbreeding, and the crossbreeding of inbred lines, have continued to be major subjects of investigation. The results for the calendar year 1919 confirm those for previous years. The most important new results have been obtained in cooperation with the Henry Phipps Institute, of Philadelphia, on the factors which affect the resistance of guinea pigs to tuberculosis. A new method of analyzing causal relations has been developed further. A study by this method of the relative importance of heredity, environment, and irregularities in development in determining the coat pattern of guinea pigs has been published.

A Department Bulletin (No. 905) on the "Principles of Livestock Breeding" has been prepared.

#### ANIMAL HUSBANDRY EXPERIMENT FARM.

The work at the Animal Husbandry Division farm at Beltsville, Md., has followed the plan of former years. The farm is the field



laboratory for the division and furnishes the facilities for the conduct of the investigations in the breeding, feeding, and management of animals. During the year an extension of the hog paddocks was made. Considerable work was done in the construction of portable and temporary buildings, fences, gates, etc. The farm has already proved to be entirely too small for the investigations in animal husbandry which the bureau should conduct.

#### CERTIFICATION OF ANIMALS IMPORTED FOR BREEDING PURPOSES.

Under the provision of paragraph 397 of the Tariff Act of October 3, 1913, certificates of pure breeding were issued for 82 horses, 200 dogs, and 3 cats.

#### DAIRY DIVISION.

Economical milk production, and the improvement of milk products through better processes of manufacture, are the two lines of activity around which the work of the Dairy Division, under B. H. Rawl, chief, has centered during the last year. To improve the dairy cows of the country the present knowledge of methods of feeding and breeding has been presented to the producers through cow-testing and bull associations, and new knowledge is being gained through scientific investigations of breeding and animal nutrition.

Certain principles of breeding are being studied in a comprehensive project involving a large number of dairy cattle under definite plans of mating and crossing. Studies in nutrition have yielded information of value in the proper feeding of animals for milk production. In the manufacture of milk products, investigations have included the improvement and standardizing of products and a fuller utilization of by-products. Studies in factory and milk-plant management and in sanitation to prevent losses and to improve the products have been continued. The manufacture of the Swiss and Roquefort varieties of cheese has been standardized and introduced successfully into factories. Cultures needed in the manufacture of these products are being supplied to factories in several States. Progress has also been made in preventing defects that frequently occur in condensed milk and ice cream. Factory management investigations have aided in the economical use of fuel and power and in efficient methods of operation.

#### DAIRY EXTENSION.

Extension work in dairying, conducted in cooperation with State agricultural colleges, carries dairying into new sections and introduces new practices developed through research. Substantial progress has marked the year's work, which has centered largely around the cow-testing and bull associations and the extension of the cheese industry.

#### SOUTHERN DAIRYING.

Efforts of the extension forces in the South have been directed toward strengthening the foundation of dairying through the use of better cattle, and, as a whole, the progress made has been in quality rather than increase in numbers of cattle. The 12 cow-testing asso-

ciations and 49 bull associations now operating in Southern States have done much to bring this about.

Three women agents have fostered greater home consumption of milk and improvement of farm butter, and an illustration of the interest aroused is found in the purchase of 322 family cows in 11 counties, which was a direct result of this work.

Some of the more specific accomplishments of the field men are the erection of 92 silos and 46 barns, the remodeling of 16 barns, the construction of 14 milk houses and the remodeling of 17 old ones, the purchase of 1,165 head of cattle (among which were 148 purebred bulls and 447 purebred females), herd records kept on 30 new herds, organization of 23 bull associations and 8 cow-testing associations, and reorganization of 4 old cow-testing associations.

On June 30 the curtailed appropriation caused the withdrawal of the division from the major portion of its extension work in the South.

**CHEESE-FACTORY EXTENSION.**—The development of cheese manufacture in the southern mountain sections has progressed in spite of adverse conditions as regards weather, labor, and markets. Cheese specialists have given particular attention to the organizing of new factories, to the training of cheesemakers, and to marketing problems. Efforts have been made to aid factory patrons to increase the production of milk. In North Carolina 2 new factories have been organized, making a total of 31 in the State, with an annual production of 473,253 pounds of cheese. Through the efforts of the extension men in that State 55 silos and 2 barns have been built, 16 milk houses remodeled, and 275 cows and 28 purebred bulls purchased. In Tennessee 2 new factories were added to the 6 already in operation, and the total production was 84,905 pounds of cheese. Assistance was given in the erection of 12 silos and 3 barns and in the remodeling of 6 barns. One new factory was organized in Georgia, making a total of 4 factories now in operation in that State, where conditions were not so favorable as in the other States. In Virginia the output of cheese was increased slightly, but no new factories have been built. A number of dairy cows have been brought into the cheese-factory territory, and farmers are taking more interest in milk production.

**CREAMERY EXTENSION.**—Extension activities in creamery development have been carried on mainly in Tennessee, Mississippi, and North Carolina. The creameries are enlarging their business and are overcoming the feeling of uncertainty that existed previously. Dairy Division specialists have assisted creameries in improving the quality of their manufactured products, aided in the selection and installation of equipment, and given help in accounting and other lines of work tending to improve the efficiency and economy of operation. In North Carolina production has been increased 23 per cent. Five new plants for handling city milk and manufacturing ice cream and butter were established during the year, not including plants for making ice cream only. The creamery industry in Tennessee is in a period of growth and development. Cooperative creameries have been established and assistance given to 14 factories. In Mississippi the efforts of the extension workers to improve the quality of cream used in buttermaking have been reflected in the

higher quality of the butter produced. Much has been done to interest farmers in winter dairying, and aid has been given to ice-cream plants.

#### WESTERN DAIRYING.

The chief results of the extension work in the Western States has been along lines of better breeding, an improvement made necessary by the high cost of production. The efforts of the extension men have been directed toward the improvement of the quality of butter and Cheddar cheese through personal assistance given to creameries and factories. Cheese specialists cooperated with State colleges in conducting short courses on practical cheesemaking.

In the work for the improvement of market milk some striking results have been obtained in western cities in lowering the bacterial count and generally improving the quality of milk supplies. Contests were held in 17 cities, 910 samples of milk were scored, and special assistance was given to city and State departments.

In the West 14 cow-testing associations were organized or reorganized, and 6 bull associations were organized. Assistance was given in many other lines of work, including the erection of 1,685 silos, the selection of 50 purebred bulls and 318 cows, and the supervision of herd records on 808 cows.

#### COW-TESTING ASSOCIATIONS.

The number of cow-testing associations active at the close of the fiscal year was larger than at any previous time since the work was begun. These associations, which are encouraged and supervised by the Dairy Division, are made up of groups of dairymen who collectively employ a tester to keep records on production, butterfat test, feed consumption, and other data concerning each cow. On July 1, 1920, they numbered 467, as compared with 383 associations active on July 1, 1919. Wisconsin continues to lead, with 114; Pennsylvania ranks second, with 64; Ohio third, with 41; and New York fourth, with 28. Arkansas reported a cow-testing association for the first time. A lack of available, properly trained testers continues to limit the increase in the number of associations. The salaries of testers now range from \$70 to \$125 a month, compared with from \$50 to \$75, formerly paid. In several States campaigns to stimulate the use of purebred sires have had marked success. In Wisconsin 47 of the 115 associations are now free from scrub and grade sires.

The Dairy Division has revised the system of blanks and books used by testers, so as to make possible more accurate and complete records and provide for monthly reports to the State supervisors of cow testing. The high costs of feed and labor, the chief difficulties met by the dairy industry during the year, have caused dairyman to seek increased help from extension workers.

STUDY OF COW-TESTING RECORDS.—Tabulation of the yearly records of 38,532 association cows, which was completed this year, has brought to light much valuable information on the relations between milk and butterfat production, butterfat test, income over cost of feed, and other factors. The average milk production per cow-year



was 5,980 pounds; butterfat, 246 pounds; butterfat test, 4.11 per cent; income over cost of feed, \$55.69; returns for \$1 expended for feed, \$2.11. The records show that in those associations where the work has been continued for a long period the production has generally increased from year to year. As production increased, the income over cost of feed increased rapidly, and for each increase of 50 pounds in butterfat there was an increase of \$15 in income over cost of feed. Cows that freshened in the fall produced more milk and butterfat and greater average income over cost of feed than those which freshened in the spring or summer. Large cows excelled small cows of the same breed in production of milk and butterfat and in income over cost of feed. As the butterfat test increased, the average production of butterfat advanced and average production of milk declined. These records also indicate that cows remain in the herd an average of about 4.7 years.

#### COOPERATIVE BULL ASSOCIATIONS.

The number of active bull associations increased from 78 on July 1, 1919, to 120 on June 30, 1920. This is the largest increase since the work began, and is partly due to the momentum gained during the preceding year, when the first real effort was made to extend the work. Eighteen of the new associations are in South Carolina, Alabama, and Mississippi, where a large part of the active field work has been done by the cooperative extension men. Reports from the associations which have been in operation for a fairly long time show that the bull association is fulfilling its purpose of improving the herds, and that the daughters of association bulls have generally excelled their dams in milk and butterfat production. In one Maryland association 21 daughters of association bulls excelled their dams in yearly production by an average of 963 pounds of milk and 44 pounds of butterfat.

Plans drawn in the division for a bull barn and pen that will permit safe handling of the bull have been used extensively and have given general satisfaction.

#### COMBATING INFECTIOUS DISEASES IN DAIRY HERDS.

On account of the supposed danger of spreading disease by means of bull associations, and because of the opportunity for cooperation in cow-testing and bull associations, some preliminary work has been done in connection with these organizations, looking toward systematic efforts at a later period for the eradication of tuberculosis and contagious abortion. Assistance was given in controlling abortion in Virginia and Mississippi and in combating tuberculosis and abortion in South Carolina.

#### UTILIZATION AND IMPROVEMENT OF DAIRY PRODUCTS.

Successful campaigns to promote the increased consumption of dairy products in cities, towns, and rural districts have been carried on by the Dairy Division and the States Relations Service of the department in cooperation with State agricultural colleges and local agencies.

**RURAL CAMPAIGNS.**—A feature of the campaign in Iowa was the State-wide observance of "milk week" in October. Schools, health boards, libraries, home demonstration agents, county agents, women's clubs, and other organizations cooperated in the work and more than 31,000 people were reached directly. As a result, a large increase in milk consumption was noted. During the winter short courses were held and demonstrations were given on milk dishes, and during the summer attention was given to exhibits at State and county fairs.

In Kansas activities for the greater utilization of milk were carried on throughout the State. In Marion County a striking demonstration was accomplished with school children. A survey showed that 69 per cent of the children in the schools were 2 per cent below normal in weight, and that 34 per cent were 8 per cent or more underweight. Short courses, milk-feeding demonstrations, and essay contests on the food value of milk were effectively employed to remedy this condition. At one school where each child drank a pint of milk daily for four months the average gain in weight was 3.53 pounds for each child, which is twice the average normal gain.

**URBAN CAMPAIGNS.**—At the request of the extension divisions of the State agricultural colleges in Pennsylvania, Missouri, Washington, Iowa, and Kansas personal assistance was given by the Dairy Division in conducting milk campaigns in various cities in those States. These campaigns were put on with the cooperation of various local organizations. Talks and demonstrations at schools, factories, stores, and clubs, essay and poster contests, store-window exhibits, and other methods were used to stimulate interest in dairy products and to present information on the food value of milk. At Pittsburgh there was a very large increase in the consumption of milk, and one firm reported a 79 per cent increase in sales of butter. An effective campaign in Kansas City, Mo., resulted in an average daily increase in consumption of 33,416 quarts, or 14.7 per cent. Following the Spokane campaign, reports from milk distributors showed increases in sales at four plants amounting, respectively, to 20, 25, 29, and 30 per cent. A campaign held in Seattle was conducted almost entirely through the public schools, and a 10 per cent increase in the consumption of milk was reported. Increases in the consumption of milk resulting from campaigns in other cities were reported as follows: Davenport, Iowa, 15 per cent; Iowa City, Iowa, 25 per cent; Clinton, Iowa, 15 per cent; Topeka, Kans., 25 per cent. In addition to increases in milk consumption, large increases in the use of butter and cottage cheese in many cities were reported.

**MILK UTILIZATION IN THE SOUTH.**—In the Southern States the efforts were directed largely toward (1) increasing the use of milk and dairy products on the farm, through campaigns for cows on every farm, and (2) improving farm dairy products by practical demonstrations in schools and in farm kitchens. In Louisiana 274 cottage-cheese demonstrations, 207 buttermaking demonstrations, and 236 demonstrations on milk products were made and 26 meetings were held. As a result, 2,698 families were reported as using more milk, 178 cows were brought in where there were none before, 34 boys' and girls' clubs were organized, and much improved dairy apparatus

was purchased. In South Carolina the activities resulted in the increased use of milk in 1,384 families and in the purchase of 73 family cows. Sixty demonstrations were given in buttermaking and 38 in making other dairy products. The work in Mississippi resulted in placing 322 family cows in 11 counties and in the purchase of 2,040 pieces of improved dairy equipment. Dairy clubs were organized in 11 counties, 49 meetings were held, and 76 demonstrations were given.

#### DAIRY MANUFACTURING INVESTIGATIONS.

##### CREAMERY DEVELOPMENT AND IMPROVEMENT.

Special efforts were directed toward increasing the efficiency of creamery operation and improving the quality of manufactured products. In the South, where the creamery business is comparatively new, help was given in the organization of local creameries, in the selection and arrangement of equipment, and in increasing the efficiency and economy of operation.

With the higher prices of coal and wood has come new appreciation of the work on fuel and power efficiency and refrigeration, which has been continued with creameries in Minnesota, Iowa, Wisconsin, and South Dakota. Particular attention has been given to the saving of fuel through the use of exhaust steam, hot-water heaters, and as a result 27 heaters were installed. Electric motors were installed in several creameries on the recommendation of the Dairy Division, as a means of obtaining more economical power. Assistance has also been given in the planning of refrigerator storage rooms at a number of creameries.

##### THE GROVE CITY CREAMERY.

The cooperative creamery at Grove City, Pa., has continued in successful operation under the direction of the Dairy Division. The making and marketing of comparatively large quantities of cheese of the Roquefort, Swiss, and Camembert varieties under commercial conditions have furnished an opportunity for study and improvement of the manufacturing methods and have demonstrated that those varieties of cheese, heretofore largely imported, can be profitably made in this country. The products were of high quality. The year's output of Swiss cheese was 112,000 pounds; of Roquefort, 12,378 pounds; and of Camembert, 7,737 pounds. The butter made amounted to 505,904 pounds, part of which was packed in sealed tins for export. Considerable attention has been given to the working out of a satisfactory cost-accounting system.

##### INSPECTION OF BUTTER FOR THE NAVY.

During the last season 1,392,369 pounds of butter, made for the Navy at 43 creameries, was passed on by 29 inspectors of the Dairy Division. The average score for all samples of the butter taken at the time of manufacture was 95; the average score after storage was 92.71. The specifications require that the butter be made from sweet cream. The excellent keeping qualities of this butter are



shown by the high quality of the butter on rescoring after six months. There was not the metallic or the fishy flavor so common in storage butter. One of the outstanding results of this work is the demonstration to small creameries that with a little effort a much better quality of cream can be obtained and a correspondingly higher quality of butter manufactured. The lessons learned in the manufacturing of high-grade butter for the Navy have made it possible for creameries that previously produced inferior butter to obtain a better product and an increased price throughout the year.

#### INSPECTION OF RENOVATED-BUTTER FACTORIES.

The inspection of renovated-butter factories was conducted at 11 plants, one of which ceased operation during the year. Their output for the fiscal year amounted to 9,641,675 pounds of butter, a decrease of 7,025,780 pounds, or 42 per cent, from the preceding fiscal year.

#### STUDENTS' JUDGING CONTEST.

The third students' contest in judging dairy products, held at the National Dairy Show, Chicago, in October, 1919, was superintended by the Dairy Division, and was the largest and most successful contest so far held. Teams of three men each from seven State agricultural colleges competed in the judging. These contests have stimulated interest among students of agricultural colleges in the judging of dairy products and have increased their knowledge of the market qualities of butter, cheese, and milk.

#### MARKET-MILK INVESTIGATIONS.

##### IMPROVEMENT OF MILK SUPPLIES.

In the cooperative work in dairy sanitation surveys of the milk supplies of 12 cities in 9 States were made. These surveys took into consideration the source and handling of the milk, together with laboratory and inspection methods used in safeguarding its quality. Numerous other cities were visited by Dairy Division representatives for conferences, milk contests, and other work in the interest of milk improvement. In the course of this work 508 farms were visited and inspected and 356 bacterial counts made. Assistance was rendered to various cities and towns in the formulation of milk ordinances. Aid was given also in conducting milk contests in 6 States and at the National Dairy Show. The State colleges have been urged to take over the contest work in their respective States.

The dairy farm at Beltsville was inspected and scored five times and the United States Naval Academy dairy at Gambrills, Md., ten times.

At Grove City the work on the milk-grading system was continued. During the summer all the farms, and during winter 135 of the farms, of the patrons of the local creamery were visited and rated on sanitary conditions of milk production. Since the work was begun considerable improvement in sanitary conditions has been noted and more interest has been taken by dairymen in proper care of the milk.

Milk-plant specialists gave personal assistance and advice in the organization and operation of cooperative and other milk plants and pasteurizing plants. Three sets of stock plans for milk plants were

prepared and special plans were made up for a number of individual plants.

#### REQUIREMENTS FOR MILK PRODUCTION.

Investigations on the cost and requirements of milk production have progressed to a point where accurate information is now available for representative dairy sections throughout the United States. Two-year studies on groups of dairy farms in Indiana, North Carolina, and Vermont had been made previously, and this year the field work for similar investigations was completed in the States of Washington and Louisiana. Investigations are under way in Nebraska and Delaware. The data collected have already been found to be of great value and should help in determining an equitable price to be paid farmers for milk. The requirements have been obtained in terms of pounds of feed, hours of labor, etc., so that dairymen may determine the cost of production at any time by substituting current prices for the requirements listed.

#### CLEANING MILKING MACHINES.

In continuation of the efforts to devise a simpler method of cleaning and sterilizing milking machines so as to prevent excessive numbers of bacteria in milk, tests were made on farms in Virginia and Maryland, and while good results were obtained with some methods there is still room for improvement and need for further study. The chlorine-solution method and the hot-water method have been tried out with different makes of machines, and so far the hot-water method for sterilizing all parts has resulted in more uniformly low bacterial counts. The investigations have indicated that many operators do not understand the construction of the machines from the sanitary standpoint and that when they become familiar with the machines and use ordinary care great reductions in the bacterial count are obtained.

#### OTHER ACTIVITIES.

Some experiments on the whipping qualities of cream were made. The results indicate that age and fat content, rather than acidity, are the determining factors of the whipping quality, and that cream as low in fat as 20 per cent will whip satisfactorily if held at a low temperature for 48 hours.

The Dairy Division exhibit at the 1919 National Dairy Show surpassed all previous efforts of the division. The 10,000 square feet of floor space allotted was taken up with booths representing 12 phases of dairy work.

Special attention was given by market-milk specialists to the treatment of gargety cows, the elimination of garlic flavor in milk, and the effect of silage in causing flavors and odors in milk. Extensive tests on the last-mentioned problem indicate that the flavor and odor of corn silage in milk is due to cows eating the silage and not to absorption of the silage odor from the air, as commonly believed, and that aeration is an effective means of reducing the flavor and odor.

Further work on the suitability of the red organism R-2 for testing the passage of milk through the retarder in pasteurization has

shown that this organism is not pathogenic and can be safely used in such work.

Studies on the transportation of milk and the effect of different methods of refrigeration during transportation have been continued, and various types of milk cans have been tested in experimental shipments.

#### DAIRY RESEARCH LABORATORIES.

##### NUTRITION EXPERIMENTS.

Nutrition experiments with dairy cattle have continued to show the beneficial effect of increasing the calcium and phosphorus content of the ration. This is especially true of cows fed according to commonly accepted feeding standards, and indicates that such cows are probably not getting sufficient quantities of bone-building material. Experiments on the changes produced in the blood of cows by changing the alkalinity of the ration show that the response of cows to such change differs in several respects from that of omnivorous and carnivorous animals. Silage fed in large amounts acts as an acid-producing feed. This is contrary to what would be expected from its ash content, and is a fact which may have considerable practical importance. It has also been demonstrated that the amino acids of the blood are the precursors of the milk proteins.

##### BACTERIOLOGY.

The work on the sporogenes test for the quality of milk has been completed, and it has been shown that if a sufficiently large quantity of milk is tested from each sample there is some relation between this test and the conditions under which the milk was produced. The test will at best differentiate only between extremes in methods of production.

A butter culture which is widely used commercially has been found to consist of two types of streptococcus: one which produces a high acid in milk, and a sharp flavor, with but little volatile acid; and another producing less total acid but considerable volatile acid. When they are grown together in milk the volatile acid is increased and the flavor of the culture is greatly improved. The isolation of the second type was made possible by the use of a new milk-powder agar. This medium gives high counts with milk and makes possible a qualitative as well as quantitative count.

Preliminary work on the sterilization of dairy utensils by dry heat has shown that spores can not be destroyed on soldered tin in this way, but very satisfactory reductions in bacteria can be obtained in badly contaminated cans by exposure at comparatively low temperatures and for short periods.

Some bacteriological work of a nature too technical to be described in this report has been carried on, and the results of some of it have been published.

##### ICE CREAM.

Experiments indicate that "sandiness" in commercial ice cream is due to crystallization of the lactose and that it is influenced by the



temperature at which the cream is stored. A collection of definite formulas for ice-cream mixes was compiled and distributed to ice-cream makers.

#### CONDENSED MILK.

The work on "buttons" in sweetened condensed milk, a problem of importance to the manufacturer, resulted in the working out of a method of inhibiting mold growth by reducing the air in the can. The factors influencing the viscosity of sweetened condensed milk have been ascertained, and it has been shown that the viscosity is determined by the condition of the casein and albumen, and is greatly influenced by the temperature of forewarming and by the phosphate content. Considerable progress was made on the commercially important question of devising a test for grading milk at condenseries, and the alcohol test was found to be closely correlated with the effect of heat on the evaporated milk. The resignation of the investigator has made it impracticable to continue this work. One phase of the investigation of factors influencing the coagulation of evaporated milk in sterilizing is nearly completed. Bacteriological investigations on sweetened condensed milk show that growth occurs in sugar concentrations up to 50 per cent.

#### CHEESE.

Work on Swiss cheese consisted principally in introducing the use of cultures into factories and the testing of methods of manufacturing on a large scale. In the manufacture of Roquefort cheese at Grove City the system devised for controlling the temperature and humidity of the cooling rooms has given good results. Arrangements have been made to assist one factory in the commercial manufacture of Roquefort. Camembert cheese of very good quality was made during the year by the methods devised by the Dairy Division. Cheese made by the division by the Parmesan method and ripened for two years has been pronounced by competent judges to be typical Parmesan.

#### UTILIZATION OF CREAMERY BY-PRODUCTS.

In an effort to solve some of the problems troubling the dairy industry considerable attention has been given to the development and adoption of methods of utilizing by-products from creameries. Attempts to make from centralizer buttermilk a casein which would be suitable for paper coating have not given satisfactory results. A continuation of work on the grain-cured method of making casein has indicated that this method may be applied successfully to pasteurized milk, and that the use of large centrifugals for draining, washing, and pressing the curd reduces the time required by over 12 hours.

Some effort has been made to demonstrate the value of concentrated whey for poultry food, and a process has been developed for separating the albumen of the whey on the first concentration, in a soluble form suitable for use in cooking. By this process a powder was obtained which may be used as a substitute for eggs in cake making. Machinery is being installed at Grove City for making

this product on a small scale. The sugar obtained by this method is in a satisfactory condition for refining, and in connection with the albumen shows promise of providing a market for whey.

In an effort to find some means of converting lactose into a product which could be marketed profitably, it was found that lactose may be converted into lactates, and lactates into propionic and acetic acids, through the action of a certain organism. The propionic acid, which is produced at a faster rate, is used for making perfumes, and commands a good price.

#### SILAGE INVESTIGATIONS.

Investigations have been continued on the fermentation of corn silage made from corn at various stages of maturity, and studies have also been made on the composition of sunflower and Sudan grass at different stages of growth, to determine the best time for ensiling.

#### DAIRY EXPERIMENT FARM.

At the Dairy Division experiment farm, Beltsville, Md., practical experimental work was continued on various problems of dairy management. The dairy herd now contains 140 animals, an increase of 35 over the number at the farm at the end of the last fiscal year, and the farm of 190 acres produced sufficient hay and silage to maintain the herd and work stock.

#### INBREEDING EXPERIMENT.

The inbreeding experiment begun in 1912 is nearing completion, and considerable data have been obtained. Cows of the first generation show an improvement in dairy ability, this being more marked with the Holsteins than with the Guernseys. Owing to an outbreak of abortion a large number of calves were lost, which interfered with the experiment. A number of characteristic deformities have appeared among the calves, evidently due to the mating of closely related Guernseys, but no such results were obtained from inbreeding Holsteins or from outcrossing Guernseys. Whether the results with the inbreeding of Guernseys were due to the particular bull used or whether similar results would have been obtained with other bulls and breeds if inbreeding were long continued can only be determined by further investigation.

#### MILKING EXPERIMENTS.

Experiments to determine the effect of irregular milking and feeding upon production have been continued, previous work having shown that with average cows irregular milking alone is not detrimental. A comparison of milking twice a day and three times has shown an increased production varying from 0.42 to 22.43 per cent in favor of milking three times a day. Milking four times a day as compared with three times has so far resulted in a variation in production, from a decrease of 2.26 per cent to an increase of 11.68 per cent.

## FEEDING EXPERIMENTS.

Accurate feed records of 11 heifers to the age of 2 years, with feed figured at current prices in Maryland, show a feed cost of \$155.54, thus emphasizing the need of first-class sires, close culling, and the provision of cheap feed.

A feed mixture for the raising of calves, costing at present prices less than 6 cents a pound, has been developed. With this mixture a total of only 300 pounds of milk is fed, and while the gains made are not equal to those in calves fed on skim milk, the calves give evidence of being well nourished and are not troubled with digestive disorders to any greater extent than are the calves fed on skim milk.

Cows fed on Sudan-grass silage produced 14.8 per cent less milk, and those fed sunflower silage 14.9 per cent less, than cows fed on corn silage. As a feed for dairy cows dried sweet-potato meal showed an approximate value of 90 per cent compared with corn meal. No difference was noted in the palatability of the two meals.

## SILAGE INVESTIGATIONS.

Corn planted alone yielded 11.5 per cent more silage than corn and soy beans planted together. Sunflowers, on account of their stiff, brittle stalks and their susceptibility to damage from wind, are not so readily made into silage as corn.

## DAIRY STATISTICS.

The trend of dairying in this and foreign countries has been followed with a continued compilation and study of production and trade. The various sources of information are carefully followed and new data added from time to time. Two bulletins were published, one on "The Trend of the Cheese Industry" and the other on "The Trend of the Butter Industry in the United States and Other Countries." Charts were prepared showing the trend of the dairy industry, factory production of butter, cheese, and condensed milk, the loss of purebred bulls, and other miscellaneous subjects.

## DAIRY ENGINEERING.

Engineering specialists of the Dairy Division prepared plans and specifications for construction work and equipment as required by the division and superintended construction at the Beltsville farm, the Grove City creamery, and other plants. In reply to inquiries, information was furnished on the construction of dairy buildings and 825 blue prints of plans for silos, barns, etc., were sent out.

Special assistance was given in the installation of machinery and the enlargement of the cheese-curing rooms at the Grove City plant and in the construction of a granary and a sewage-disposal system and the installation of an electrical generating set at the Naval Academy dairy. Plans were prepared for remodeling the temperature-control apparatus of the experimental cheese-curing room of the dairy research laboratories and for various other apparatus. Temperature-control systems for the Biochemic and Pathological Divisions were designed and maintained, and assistance was given to other



bureaus in designing similar equipment. Considerable refrigeration work was done in connection with the bureau plant, the Grove City creamery, and the experimental abattoir at Beltsville. An air washer and cooler was designed for the experimental cheese rooms, and a number of special plans were prepared for outside concerns.

#### DAIRY-CATTLE BREEDING.

The comprehensive dairy-cattle breeding experiments, including inbreeding, line breeding, and outcrossing, which were begun last year for the purpose of obtaining definite knowledge of the fundamental principles which underlie dairy cattle improvement, have been expanded, and some progress has been made. A Jersey bull and 31 Jersey cows were procured for the inbreeding and outbreeding experiment at the Beltsville farm, and a new sire was obtained to head the Holstein-Friesian line-breeding experiment. Nine foundation animals have completed creditable yearly records ranging from 404.5 to 777.7 pounds of butterfat.

Bulls have been lent to the New Jersey and West Virginia experiment stations for cooperative breeding experiments, and a cooperative experiment has also been begun at the Walker-Gordon farms, Plainsboro, N. J.

A compilation of Holstein-Friesian advanced-register data for studies pertaining to principles of breeding has been completed and prepared for publication. Similar studies are being made of Guernsey advanced-register and Jersey register-of-merit data.

#### MEAT INSPECTION DIVISION.

The Federal meat inspection, conducted by the Meat Inspection Division, with Dr. R. P. Steddom as chief, shows a decline in the total number of animals slaughtered, in the quantity of meats processed, and in the amount of meat and product certified for export, as compared with the high marks of the preceding year, though the number of animals slaughtered is greater than for any year prior to 1919.

#### INSPECTION OF DOMESTIC MEATS.

Inspection was conducted at 897 establishments in 262 cities and towns, as compared with 895 establishments in 263 cities and towns during the fiscal year 1919. Inspection was begun at 65 establishments and withdrawn from 67 during the year, as compared with 84 and 73 respectively, during the fiscal year 1919. Among the establishments at which inspection was begun were three at which horses were slaughtered. Inspection was withdrawn from 57 establishments on account of discontinuance of slaughtering or of interstate business, from 4 by request, from 4 on account of consolidation, and from 2 which were granted exemption from inspection.

#### ANTE-MORTEM AND POST-MORTEM INSPECTIONS.

The ante-mortem and post-mortem inspections are given in the following tables:

*Ante-mortem inspection of animals.*

Class of animals.	Passed.	Suspected. <sup>1</sup>	Condemned. <sup>2</sup>	Total inspected.
Cattle.....	9,579,104	111,602	19	9,690,725
Calves.....	4,154,157	6,690	2	4,160,849
Sheep.....	12,346,155	7,853	3	12,354,011
Goats.....	77,170	59	.....	77,229
Swine.....	38,854,770	92,127	2,001	38,948,898
Horses.....	1,073	16	4	1,093
Total.....	65,012,429	218,347	2,029	65,232,805

<sup>1</sup> This term is used to designate animals found or suspected of being unfit for food on ante-mortem inspection, most of which are afterwards slaughtered under special supervision, the final disposal being determined on post-mortem inspection.

<sup>2</sup> For additional condemnations see succeeding tables.

*Post-mortem inspection of animals.*

Class of animals.	Passed.	Condemned.	Total inspected.
Cattle.....	9,651,217	58,602	9,709,819
Calves.....	4,213,738	13,820	4,227,558
Sheep.....	12,314,799	20,028	12,334,827
Goats.....	77,135	135	77,270
Swine.....	38,848,438	133,476	38,981,914
Horses.....	1,025	64	1,089
Total.....	65,106,353	226,125	65,332,477

The next two tables show the diseases and conditions for which condemnations were made.

*Diseases and conditions for which condemnations were made on ante-mortem inspection.*

Cause of condemnation.	Cattle.	Calves.	Sheep.	Goats.	Swine.	Horses.
Ascites.....	.....	.....	.....	.....	1	.....
Arthritis.....	.....	.....	.....	.....	7	.....
Blackleg.....	.....	1	.....	.....	.....	.....
Congestion.....	.....	.....	.....	.....	1	.....
Dropsy.....	.....	.....	.....	.....	1	.....
Emaciation.....	1	1	1	.....	40	.....
Enteritis.....	.....	.....	.....	.....	1	.....
Hog cholera.....	.....	.....	.....	.....	976	.....
Influenza.....	.....	.....	.....	.....	.....	1
Injuries.....	3	.....	.....	.....	17	.....
Pneumonia.....	8	.....	1	.....	124	.....
Pol. arthritis.....	.....	.....	.....	.....	1	.....
Pregnancy and recent parturition.....	2	.....	.....	.....	4	.....
Purpura hemorrhagica.....	.....	.....	.....	.....	.....	1
P. yemia.....	.....	.....	.....	.....	3	2
Septicemia.....	.....	.....	.....	.....	8	.....
Temperature.....	3	.....	1	.....	786	.....
Tetanus.....	1	.....	.....	.....	.....	.....
Tuberculosis.....	1	.....	.....	.....	.....	.....
Tumors and abscesses.....	.....	.....	.....	.....	31	.....
Total.....	19	2	3	.....	2,001	4

*Diseases and conditions for which condemnations were made on post-mortem inspection.*

Cause of condemnation.	Cattle.		Calves.		Sheep.	
	Car-casses.	Parts.	Car-casses.	Parts.	Car-casses.	Parts.
Actinomycosis.....	556	135,309	13	1,998		
Adenitis.....						3
Arthritis.....		1		1		4
Asphyxia.....	3		15		49	
Autointoxication.....					1	
Blackleg.....	21	1	9			
Bone diseases.....	25	3	1			
Caseous lymphadenitis.....					2,050	62
Cellulitis.....						
Congestion.....	10	1	1		34	
Contamination.....		277	1	2	1	383
Cysticercus.....	212	882	23	3	131	1
Dropsical diseases.....	10		3		9	
Edema.....						
Emaciation.....	7,652		3,106		9,485	
Exhaustion.....			1			
Frozen.....						
Gangrene.....	78	1	14		11	
Glanders.....						
Hernia.....	11	1	1		9	
Hog cholera.....						
Hydronephrosis.....	5		1			
Icterus.....	61		132		1,216	
Immaturity.....			6,224			
Inflammation.....		6				
Injuries, bruises, etc.....	2,396	399	553	85	582	97
Leukemia.....	316	1	24		12	
Lymphangitis.....						
Melanosis.....	30	12	35	4	12	
Moribund.....	5				17	
Necrobacillosis.....	8		8		28	
Necrosis.....	7	379		2	1	8
Parasitic diseases.....	8	14			7	
Phlebitis.....			214	1		
Pneumonia, peritonitis, metritis, enteritis, pleurisy, etc.....	5,945		1,764		5,313	
Pregnancy and recent parturition.....	47				20	
Septicemia, pyemia, and uremia.....	2,861	1	687		879	
Sexual odor.....	1				3	
Skin diseases.....						
Tetanus.....						
Texas fever.....	236		416			
Tuberculosis.....	37,492	54,670	545	426	17	
Tumors and abscesses.....	606	2,101	29	344	141	69
Total.....	58,602	194,058	13,820	2,866	20,028	627



*Diseases and conditions for which condemnations were made on post-mortem inspection—Continued.*

Cause of condemnation.	Goats.		Swine.		Horses.	
	Carcasses.	Parts.	Carcasses.	Parts.	Carcasses.	Parts.
Actinomycosis.....			2	80		
Adenitis.....						
Arthritis.....				7		
Asphyxia.....			1,170			
Autointoxication.....			1			
Blackleg.....						
Bone diseases.....			44	3		
Caseous lymphadenitis.....	3					
Cellulitis.....			2	240		
Congestion.....			24			
Contamination.....			238	564		
Cysticercus.....			242	17		
Dropsical diseases.....			68			
Edema.....			1			
Emaciation.....	65		966		37	
Exhaustion.....			3			
Frozen.....			12			
Gangrene.....			18			
Glanders.....					13	
Hernia.....			68			
Hog cholera.....			23,789			
Hydronephrosis.....			5			
Icterus.....	3		3,385		1	
Inflammation.....				1		
Injuries, bruises, etc.....	2		847	5,844		1
Leukemia.....			145			3
Lymphangitis.....						
Melanosis.....			60	6		
Moribund.....			88			
Necrobacillosis.....			1	8		
Necrosis.....			4	4		
Parasitic diseases.....			72			
Pneumonia, peritonitis, metritis, enteritis, pleurisy, etc.	10		22,306		7	
Pregnancy and recent parturition.....	23		51			
Septicemia, pyemia, and uremia.....	15		11,652		4	
Sexual odor.....	5		1,103			
Skin diseases.....			6	6		
Tetanus.....			1			
Tuberculosis.....			65,609	535,631		
Tumors and abscesses.....	4	1	1,493	8,169	2	
Total.....	135	1	133,476	550,580	64	4

The following table shows the total condemnations on ante-mortem and post-mortem inspections combined:

*Summary of condemnations.*

Class of animals.	Animals or carcasses.	Parts.
Cattle.....	58,621	194,058
Calves.....	13,820	2,866
Sheep.....	20,031	627
Goats.....	135	1
Swine.....	135,477	550,580
Horses.....	64	4
Total.....	228,148	748,136

In addition to the foregoing, the carcasses of 79,564 animals found dead or in a dying condition were tanked, as follows: Cattle, 3,695; calves, 4,346; sheep, 10,494; goats, 166; swine, 60,842; horses, 21.

#### INSPECTION OF MEAT AND PRODUCTS.

The inspection and supervision of meats and products prepared and processed are shown in the following table, which is a record only of supervision performed and not a statement of the aggregate quantity of products prepared. The same product is sometimes duplicated by being reported in different stages of preparation under more than one heading.

#### *Meat and meat food products prepared and processed under inspection.*

Kind of product.	Pounds.	Kind of product.	Pounds.
Placed in cure:		Lard stearin.....	939,857
Beef.....	192,830,354	Compound and other substitutes...	328,566,547
Pork.....	2,903,853,984	Pork to be eaten uncooked.....	48,534,424
All other.....	4,091,879	Oleo stock and edible tallow.....	67,213,755
Sausage, chopped.....	662,520,938	Oleo oil.....	215,904,991
Canned product:		Oleostearin.....	81,873,422
Beef.....	175,919,675	Oleomargarin.....	217,561,569
Pork.....	29,325,827	Miscellaneous products.....	1,487,483,291
All other.....	6,275,473	Horse meat:	
Sterilized product:		Cured.....	254,165
Beef.....	3,579,964	Sausage, chopped.....	32,960
Pork.....	9,691,405	Miscellaneous.....	12,460
All other.....	13,693		
Meat extract.....	1,063,449	Total.....	7,755,158,142
Lard.....	1,316,917,697		
Lard oil.....	694,363		

The following quantities of meat and meat food products were condemned on reinspection on account of having become sour, tainted, putrid, unclean, rancid, or otherwise unwholesome: Beef, 7,747,358 pounds; pork, 10,185,442 pounds; mutton, 131,794 pounds; veal, 109,073 pounds; goat meat, 4,857 pounds; horse meat, 23,124 pounds; total, 18,201,648 pounds.

#### MARKET INSPECTION.

Market inspection, to facilitate interstate deliveries of meats and products, was conducted in 45 cities.

#### MEAT AND PRODUCTS CERTIFIED FOR EXPORT.

The following products were certified for export: Beef and beef products, 384,872,098 pounds; pork and pork products, 1,695,457,263 pounds; mutton and mutton products, 6,650,904 pounds; horse meat and products, 153,762 pounds; total, 2,087,134,027 pounds. In addition 996 certificates were issued covering the export of 19,513,950 pounds of inedible animal products.

#### EXEMPTION FROM INSPECTION.

The provisions of the meat-inspection law requiring inspection usually do not apply to animals slaughtered by a farmer on the farm nor to retail butchers and dealers supplying their customers. The

retail butchers and dealers, however, in order to ship meat and meat-food products in interstate or foreign commerce, are required first to obtain certificates of exemption. The number of exemption certificates outstanding at the close of the fiscal year was 2,622, an increase of 71 over the preceding year. During the year 79 certificates were canceled, 71 on account of the dealers retiring from business or ceasing to make shipments, and 8 for violations of the regulations. During the year 33,339 shipments were made by retail butchers and dealers holding certificates of exemption, as compared with 33,166 shipments during the fiscal year 1919. The shipments of the year consisted of the products shown in the following table:

*Shipments by retail butchers and dealers under certificates of exemption from inspection.*

Product.	Number.	Pounds.
Beef, carcasses (752 quarters).....	188	80,695
Veal, carcasses.....	24,855	2,112,433
Sheep, carcasses.....	402	19,204
Swine, carcasses.....	325	38,760
Beef, fresh.....		984,316
Veal, fresh.....		225,264
Mutton, fresh.....		161,471
Pork, fresh.....		197,855
Cured meats.....		211,380
Lard.....		15,700
Sausage.....		84,382
Miscellaneous (scrapple, tripe, headcheese, etc.) .....		39,982
Total.....	25,760	4,171,442

During the year 62,983 interstate shipments were made of meat and meat food products from animals slaughtered by farmers on the farm, as compared with 60,197 shipments made during the fiscal year 1919. The following table shows the products composing these shipments:

*Shipments of farm-slaughtered products under exemption from inspection.*

Product.	Number.	Pounds.
Beef, carcasses (1,505 quarters).....	376	143,741
Calves, carcasses.....	84,594	7,386,672
Sheep, carcasses.....	3,113	106,422
Swine, carcasses.....	9,105	1,140,799
Beef, fresh.....		36,587
Veal, fresh.....		39,738
Mutton, fresh.....		42,296
Pork, fresh.....		224,977
Cured meats.....		539,668
Lard.....		140,009
Sausage.....		119,744
Miscellaneous (scrapple, tripe, headcheese, etc.) .....		36,367
Total.....	97,188	9,957,020

#### INSPECTION OF IMPORTED MEATS.

The following table shows the inspection of imported meats and meat-food products for the fiscal year. The quantity of such imports was less than half of that for the preceding year:



*Imported meat and meat food products inspected.*

Country of origin.	Fresh and refrigerated meats.		Cured and canned meats.	Other products.	Total weight.
	Beef.	Other classes.			
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Argentina.....	502,295	3,798,106	1,963,825	2,295,405	8,559,631
Australia.....	10,032	480,188	24,821	128,564	643,605
Canada.....	25,728,475	14,050,242	987,513	416,333	41,182,563
Uruguay.....			246,604	384,886	631,490
Other countries.....	5,738,057	17,889,322	176,227	2,960,434	26,764,040
Total.....	31,978,859	36,217,858	3,398,990	6,185,622	77,781,329

The following statement shows the condemnations of imported meats and the amounts refused entry on account of lack of foreign certificates or other failure to comply with the regulations:

*Import meat products condemned or refused entry.*

Product.	Condemned.	Refused entry.
	<i>Pounds.</i>	<i>Pounds.</i>
Beef.....	149,177	204,724
Veal.....	120	
Mutton.....	74,267	2,308
Pork.....	5,774	185,134
Total.....	229,338	392,166

## INSPECTIONS FOR OTHER DEPARTMENTS OF THE GOVERNMENT.

By request of other branches of the Government, reinspections of meats and meat food products to determine whether they remained wholesome and conformed to certain specifications were made during the fiscal year, as shown in the following table:

*Inspections for other branches of the Government.*

Branch of Government.	Inspected.	Rejected.
	<i>Pounds.</i>	<i>Pounds.</i>
Interior Department (Indian Affairs).....	17,080	
Marine Corps.....	266,844	6,252
Navy Department.....	47,958,718	2,935,128
Panama Railroad.....	29,647	
War Department.....	4,051,416	2,554
Total.....	52,323,705	2,943,934

## LABELING OF MEAT AND PRODUCTS.

As in the past, large quantities of materials, including labels, cartons, stencils, box dies, brands, and tags, as well as inserts placed inside of meat containers and advertising matter bearing copies or reproductions of the Federal meat-inspection legend, were submitted

for approval as required under the regulations. It was necessary to disapprove a certain proportion of such material because of misrepresentations as to quantity, character, or composition of the products.

Numerous questions arose as to the character of wrappings included within the meaning of the net weight and volume law, and in the absence of previous specific decisions such matters were taken up in conference with the Solicitor and the Bureau of Chemistry. A number of definite opinions have been rendered, while some of the questions involved are still under consideration.

The question of free liquids in cans of meat and meat products was given special attention, and after conference and investigation certain changes were made in methods of computing and declaring the quantity of contents in such containers in order to render the labels informative as to the true character of the products.

Questions were raised also concerning the sufficiency of marking certain meat food products, with particular reference to added cereal and parts of carcasses other than flesh. Final decisions on some of the questions are still pending.

#### MEAT-INSPECTION LABORATORIES.

The laboratory examination of meat and meat food products prepared at establishments at which inspection is conducted has been continued in the meat-inspection laboratories maintained in Washington and six other cities. This examination consists in determining whether the product is properly labeled and contains any deleterious substance, analyzing spices, waters, and other ingredients used in the curing and preparation of meat food products, and analyzing rat exterminators, inks, etc.

The laboratories also continued to examine meat and products prepared for the Army and the Navy to determine whether they contained any harmful substance and to see that they conformed to the Army and Navy specifications.

The total number of products analyzed during the year was 58,365, of which 57,359 were domestic and 1,006 imported. Samples of 2,746 domestic and 133 imported products were found to be not in accordance with the regulations. Of 888 waters examined, 204 were prohibited for use in their untreated state where they would come in contact with meats.

The quantity of branding ink prepared and sent to meat-inspection stations for use in marking meats was 932 gallons.

All creameries preparing butter used in oleomargarin were inspected and lists were issued showing those which met the requirements relative to pasteurization.

Besides the routine work of a regulatory nature, the Washington meat-inspection laboratory has cooperated with the Animal Husbandry Division in studying the problem of soft pork. A total of 544 samples from hogs fed in different ways was examined. The results have shown clearly that the difference between soft and firm pork lies wholly in the fat. Some interesting information, believed to be of scientific value, has been gathered regarding the transfer of the food fat into body fat in the hog.

Cooperative work was done also with the experiment kitchen of the Office of Home Economics of the States Relations Service with regard to the relative shortening value of various fats.

## QUARANTINE DIVISION.

The Quarantine Division, under Dr. R. W. Hickman, chief, has continued to administer regulations governing the importation and exportation of livestock and also joint regulations of the Treasury Department and the Department of Agriculture for the sanitary handling and control of hides, wool, hay, straw, etc., offered for entry into the United States.

## INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

All possible diligence has been observed in the inspection and quarantine of animals offered for importation in order to protect the country's livestock against contagion from abroad. Importations from Canada and Mexico have continued without interruption throughout the year and in greater volume than during the preceding year. No permits were issued for the importation of ruminants and swine from the continents of Europe and Asia, on account of the prevalence of foot-and-mouth disease in continental Europe and of that and other dangerous diseases in Asia. Repeated outbreaks of foot-and-mouth disease occurred in England and Wales during the year, but the disease did not extend to Scotland, Ireland, or the Channel Islands. The importation of cattle, sheep, and swine from England was therefore not permitted, but permits were granted throughout the year for shipments from Scotland and the Channel Islands. Horses have also been admitted from Scotland but prohibited from England since February 20, 1920. Permits were issued for the importation of breeding sheep directly from New Zealand to San Francisco for quarantine. Two importations of purebred goats originating in Switzerland were permitted from the West Indies.

In revised regulations issued for the inspection and quarantine of import livestock, effective September 1, 1919, special precautions were taken to prevent the introduction of disease through horses from Europe. Special provision was made for the return of Army horses, and 121 of these animals were imported and quarantined at Newport News, Va., under conditions prescribed by the bureau and the Surgeon General of the Army. As a result of blood tests one animal was found to be affected with ulcerative lymphangitis and another with trypanosomiasis, and both were destroyed.

The following tables show the importations of the various kinds of livestock through the different ports of entry:

*Imported animals inspected and quarantined.*

Port of entry.	Cattle.	Sheep.	Swine.	Goats.	Other animals.
New York.....	736	378	1	228	447
Baltimore.....	144				
Boston.....	431	628	4		
San Francisco.....		300			2
New Orleans.....					5
Philadelphia.....					1
Newport News.....					119
Canadian border ports.....	5,961	284	210		79
Total.....	7,272	1,590	215	228	653



*Imported animals inspected but not quarantined.*

Port of entry.	Cattle.	Sheep.	Swine.	Goats.	Horses.	Other animals.
New York.....					87	.....
Boston.....					2	.....
New Orleans.....					24	.....
San Francisco.....					1	1,240
Key West.....					338	.....
Miami, Fla.....					1	.....
Portland, Oreg.....						3
Mexican border ports.....	98,604	17,548	320	14,199	6,183	5
Canadian border ports.....	495,595	145,935	4,288	72	7,306	132
Total.....	594,199	163,483	4,608	14,271	13,943	1,380

Inspectors of the bureau also made inspections and supervised the quarantine, for the Bureau of Biological Survey, of 23,473 quail imported from Mexico for-breeding purposes.

The animal-quarantine station for the port of Baltimore was relinquished by the War Department from use for the storage of munitions and again became available for the reception of import animals.

Through the courtesy of the British Government, the bureau has continued to maintain an inspector in Great Britain, whose services were available to citizens of the United States desiring to have cattle officially tested with tuberculin at the time of purchase in the United Kingdom for importation into the United States. During the year 1,372 cattle were so tested in the United Kingdom and the Channel Islands, with the following results:

*Results of tuberculin tests of cattle for importation into the United States.*

Breed.	Tested.	Passed.	Rejected.
Aberdeen Angus.....	90	90	.....
Ayrshire.....	13	9	4
Guernsey.....	650	650	.....
Jersey.....	278	276	2
Shorthorn.....	341	329	12
Total.....	1,372	1,354	18

Eighty-six cattle not accompanied by tuberculin-test certificates signed or approved by the bureau inspector in Great Britain were tested in quarantine after arrival in the United States without reactions.

**IMPORTATIONS OF ANIMAL BY-PRODUCTS.**

While the greater part of hides, skins, wool, and other animal by-products imported into the United States are so certified as to render them eligible for importation without disinfection, a considerable volume of such materials are not accompanied by certificates showing required freedom from disease or proper disinfection prior to shipment, and consequently are only permitted entry by the customs authorities subject to handling and disinfection at destination in the United States under the supervision of this bureau. The bureau has received cordial cooperation from the Customs Division of the

Treasury Department in the handling of these shipments and from American consuls in foreign countries who are charged with the responsibility of issuing or approving certificates and reporting outbreaks of disease. Tanners in the United States have generally shown a disposition to comply with requirements and to improve sanitary conditions at their establishments.

#### INSPECTION OF ANIMALS FOR EXPORT.

There was an unusually heavy demand for the inspection and certification of livestock intended for shipment to foreign countries, especially of cattle, sheep, and swine for Central and South America for breeding purposes. Every effort has been made to make inspections and issue certificates as required by the authorities of the countries to which the animals have been consigned.

The inspection and tuberculin testing of several thousand dairy cattle for shipment to France under a special contract of the French Government and supervision of the fitting of vessels to carry such animals were continued from the preceding fiscal year and completed during the autumn. Economic conditions in Europe and improved shipping facilities apparently encouraged the exportation of cattle for slaughter, such shipments, chiefly to Belgium and France, exceeding in volume those for any like period in recent years.

Statistics of the inspection of animals for export are given in the following table:

*Inspections of animals for export.*

Kinds of animals.	To Canada.	To other countries.		Total.
		American animals.	Canadian animals.	
Cattle.....	4,392	40,888	15,547	60,827
Sheep.....	37,400	611	.....	38,011
Goats.....	37	10	.....	47
Swine.....	155	1,050	.....	1,205
Horses.....	4,734	3,367	352	8,453
Mules.....	140	1,330	.....	1,470
Total.....	46,858	47,256	15,899	110,013

Of the cattle inspected for shipment to Canada, 942 were dairy and breeding stock and were tested with tuberculin, with 11 reactors; and 3,450 were range cattle and were not tested. For shipment to other countries, 12,174 cattle passed the tuberculin test. The mallein test was applied to the horses and mules for Canada and to 82 horses and 40 mules for other countries.

In carrying out the regulations governing the overseas transportation of livestock 339 inspections of vessels were made before clearance.

#### FIELD INSPECTION DIVISION.

The Field Inspection Division, under Dr. A. W. Miller, chief, has continued its activities for the control and eradication of certain diseases of livestock and has also conducted work in the enforcement of certain livestock quarantine and transportation laws.

## ERADICATION OF SCABIES.

In the work of eradicating sheep scabies in cooperation with State officials, bureau employees made 20,371,965 inspections and supervised 9,515,720 dippings in the field. The bureau also assisted State authorities in arresting outbreaks of the disease in States where the work is not regularly carried on. In the greater part of the range areas where the disease formerly prevailed it now exists to only a slight extent and in some States not at all. In Oregon there has been an increased spread of the infection, and it is still present extensively in southern Idaho. With the exception of Missouri and one or two other States where a considerable spread of the disease among farm sheep had been noted previously, conditions in the sheep-feeding States were greatly improved during the year. In Iowa particularly the prevalence of the disease was greatly reduced.

In continuation of the cooperative eradication of cattle scabies, bureau employees made 2,925,712 inspections and supervised 1,657,418 dippings of cattle in the field. In New Mexico excellent results were obtained and the disease now exists to a slight extent only. In Kansas no progress was made toward eradication, while in the western parts of Nebraska and South Dakota and in Colorado, Wyoming, and Montana there was a considerable further spread of the infection. This spread may be ascribed largely to the unusually severe drought in the two last-named States, which, through lack of water for dipping and lack of feed and water for the stock, made a thorough dipping impossible and made it necessary to permit the movement of cattle to other areas.

Assistance was also given to the State authorities in Colorado and Vermont in measures to eradicate sarcoptic mange of cattle in those States.

## ERADICATION OF DOURINE.

Efforts to control and eradicate dourine of horses were continued vigorously and very good progress toward the final elimination of this disease was made. Of the Middle and Northwestern States where it had gained a foothold the infection is now known to exist in only two, Montana and South Dakota, and in the latter only a few cases were found during the year. In Montana considerable work remains to be done in districts that are very difficult to cover. In Arizona and New Mexico, where the disease has prevailed extensively, satisfactory progress was also made. It is believed that especially in New Mexico the disease is under good control and future progress should be fairly rapid. In Arizona the situation still presents many difficulties, more than half of all the cases found during the year having been reported from that State. In both these States the greater part of the known infection is within various Indian reservations, the animals belonging to tribal Indians. The character and inaccessibility of the country makes effective prosecution of the work exceedingly difficult. Nevertheless the infection has been greatly reduced. State officials and the Indian Office of the Department of the Interior have cooperated freely with the bureau in this work.

The bureau continued the practice of paying one-half the appraised valuation of infected horses destroyed when they were owned by citizens, such share not to exceed \$100 in any one case. The num-



ber of animals tested and the results of the tests are reported by the Pathological Division.

#### LIVESTOCK SANITARY WORK IN INTERSTATE COMMERCE.

In the course of supervising the interstate transportation of livestock to prevent the spread of animal diseases, bureau employees at market centers inspected 22,063,290 cattle, of which 24,628 were dipped under bureau supervision in order that they might continue in interstate commerce. Sheep to the number of 23,472,528 were also inspected for communicable diseases, and of these 2,744,481 were dipped under bureau supervision to comply with the regulations of the department or of the States of destination. Swine inspected numbered 39,754,970, and 574,558 of these were vaccinated against hog cholera under bureau supervision for distribution as feeding or breeding animals.

Upon request of transportation companies and shippers or to comply with laws of States to which shipments were destined, bureau veterinarians inspected 36,393 horses and mules, of which 23,742 were tested with mallein, 5 showing reactions.

During the year 27,363 cars carrying animals affected with communicable diseases were received at bureau stations. In compliance with department regulations or on request of Canadian Government officials, State officials, or transportation companies, 47,434 cars were cleaned and disinfected under bureau supervision.

To guard against the recurrence of foot-and-mouth disease, careful inspections of all ruminants and swine received at public stockyards were made by experienced veterinary inspectors specially assigned to that work, as has been the practice for a number of years. All suspected outbreaks of the disease reported to the bureau were promptly investigated, without a single case having been discovered.

#### VIOLATIONS OF LIVESTOCK TRANSPORTATION AND QUARANTINE LAWS.

The bureau has continued to report to the Solicitor of the department, for presentation to the proper officials of other departments, cases of apparent violations of livestock transportation and quarantine laws. Many of these cases have required special investigation on the part of bureau employees, such as interviewing witnesses and examining railroad and other records. Five bureau employees were regularly assigned to this work, though the greater part of the work of collecting evidence and preparing and submitting reports is done by bureau employees at stockyard centers, in connection with their other duties. The enforcement of the so-called 28-hour law has resulted in better facilities being provided for the feeding, watering, and handling of livestock in transit.

#### TICK ERADICATION DIVISION.

The administrative work for the control of the spread of Texas or tick fever and the eradication of cattle ticks which transmit this disease has been continued by the Tick Eradication Division under the direction of Dr. R. A. Ramsay, chief, in cooperation with the authorities of the Southern States affected.

## CONTINUED PROGRESS IN TICK ERADICATION.

Areas aggregating 50,555 square miles, having been freed of ticks, were released from quarantine during the fiscal year. This action makes available 62 additional counties and 33 parts of counties into which better-bred cattle from tick-free States may be safely introduced, with consequent increase in the production of beef and of dairy products. The total area released since the beginning of this work in 1906 amounts to 509,084 square miles, which is 70 per cent of the area originally infested. The work is also far advanced in a large additional territory. The following table shows, by States, the territory released during the past fiscal year:

*Areas released from quarantine as a result of eradicating cattle ticks, fiscal year 1920.*

State.	Square miles.
Alabama.....	12,991
Arkansas.....	8,130
Georgia.....	6,942
Louisiana.....	9,299
Oklahoma.....	4,346
Texas.....	8,847
Total.....	50,555

During the year 44,813,070 inspections or dippings were made of cattle for the eradication of ticks, as compared with 47,843,791 in the preceding year. There were in operation 35,045 cattle-dipping vats, where cattle were dipped under Federal or State supervision to rid them of ticks. In addition a great deal of advance work pertaining to the construction of dipping vats and preparing counties and localities for regulatory tick-eradication activities in the near future was conducted with a view to proper organization for taking up and carrying on the work in new areas. Effective cooperation in tick eradication has been received from organizations of livestock growers, business men, and landowners, and from transportation companies, as well as from individuals.

In the territory already released from quarantine there remain here and there a few infested premises or centers of tick infestation which must be held under control until the last tick can be put out of existence. It is therefore difficult to concentrate efforts in certain areas to such a degree as was done a few years ago. The cost of labor, field traveling expenses, vat-building materials, and all other accessories to tick eradication has advanced. These conditions have greatly increased the cost of tick eradication and have made it impossible to do as much work with the same appropriations as formerly. It is for this reason that during this fiscal year, with the same appropriation, fewer cattle were dipped and a smaller area was released from quarantine than during either of the preceding two years.

## SHIPMENTS FROM QUARANTINED AREAS.

The number of cattle of the quarantined area shipped under bureau supervision to market centers for immediate slaughter was 1,127,959,

which is a large decrease from the preceding year. Many cattle owners in tick-eradication localities have shown a disposition to ship for slaughter as many unprofitable cattle as possible in preference to dipping them. This was done with a view of procuring, after the ticks are eradicated, better-bred animals likely to be more profitable for breeding purposes. "Dipped ticky cattle" to the number of 2,624 were shipped to points where inspection is provided and dipping facilities maintained for further treatment for movement as non-infectious. At public stockyards 98,733 cattle were dipped and certified for movement as noninfected. For these shipments 3,458 certificates were issued. At points other than public stockyards 56,925 cattle were inspected or dipped and certified for interstate movement as noninfected, as provided for in the regulations. To cover the shipments of these cattle 1,112 certificates were issued.

### TUBERCULOSIS ERADICATION DIVISION.

The work of the Tuberculosis Eradication Division, in charge of Dr. J. A. Kiernan, chief, conducted in cooperation with State livestock sanitary officials and livestock owners, has shown a pronounced growth during the year. Active cooperation was extended to 2 additional States and the Territory of Hawaii, making a total of 45 States and 1 Territory actively participating in the campaign for the control and eventual eradication of tuberculosis from livestock. For carrying on the field work the bureau has offices in 38 cities in as many States. An average of 150 veterinary inspectors were detailed to these offices during the year, and they were supplemented by an average of 110 State employees and a few veterinarians employed by counties and cities. The activities were carried on under four main projects: (1) Eradication of tuberculosis from purebred herds, (2) eradication of tuberculosis from circumscribed areas, (3) eradication of tuberculosis from swine, and (4) testing cattle for interstate movement.

#### ACCREDITED TUBERCULOSIS-FREE HERDS.

In the eradication of tuberculosis from purebred herds and the maintenance of a list of herds of purebred cattle officially accredited as being free from tuberculosis, 695,364 cattle were tested, of which 28,616, or slightly more than 4 per cent, reacted and were removed from the herds. The number of cattle tested was more than double the number for the preceding year. There have been established as fully accredited 3,370 herds containing 82,986 cattle, and 16,599 herds containing 257,577 cattle have been once tested without reactors. This is an increase of 2,588 accredited herds and 63,965 cattle over the report compiled to April 1, 1919.

The great success of this feature of the campaign in many States has been due to several causes, chief among which were the increased knowledge concerning the movement on the part of the livestock owners and the ability of many of the States to pay indemnity for diseased cattle. In order that future demands for services under this plan may be met, plans have been put into operation which were approved by the United States Livestock Sanitary Association and representatives of the purebred cattle breeders' associations and



adopted by the bureau December 3, 1919, permitting the use of practicing veterinarians in making the tests under certain conditions.

#### ERADICATION OF TUBERCULOSIS FROM AREAS.

Work for the eradication of animal tuberculosis from circumscribed areas has been developed as a result of the active interest of organized communities. Some counties in a number of the States either have established agencies by which such counties may be entirely freed from the disease or are making plans of this nature. It is fully realized that the total eradication of tuberculosis can never be accomplished until the work is taken up on the area plan. To this end every community where sufficient evidence of interest has been displayed is being urged to lay plans for the employment of county veterinarians who will work in cooperation with the bureau and State officials. It is also deemed advisable wherever possible to obtain the assistance of counties in the payment of indemnities for tuberculous cattle. During the year Clay County, Miss., made a complete test of all the cattle within its area, with very satisfactory results. This was the first county to demonstrate the feasibility of such work. A complete test was also made in Island County, Wash., and Clatsop County, Oreg., by the bureau and State authorities, and further work of this nature is in progress in other Oregon counties.

#### ERADICATION OF TUBERCULOSIS FROM SWINE.

Steps were taken to develop a plan for tracing the origin of hogs found to be tuberculous when slaughtered under the Federal meat inspection, so that the original owner may be notified and have the stock on his premises tested with a view to eradicating the disease. The cooperation of commission men and other agencies at livestock centers is being asked. Efforts have been made also to demonstrate the practicability of tattooing all hogs shipped to inspected slaughtering establishments in order that tuberculous animals may be traced to their former owners. This has been successfully carried out at Waterloo, Iowa; Sioux Falls, S. Dak.; and Reno, Nev., and gives promise of developing into a work which will materially assist in the control of the disease. So far this method has been applied only to small lots received at packing centers by truck or wagon. After the source of tuberculous hogs has been located, the measures for eradication of tuberculosis consist of tuberculin testing of cattle on the farm and disposing of reactors and in some cases testing the remaining hogs. The sterilization of skim milk and other by-products of creameries when they are to be fed to swine is advised.

#### INSPECTION AND TESTING FOR INTERSTATE MOVEMENT.

Realizing the utter impossibility of controlling the tuberculin testing of cattle intended for interstate shipment with the relatively small force of regularly employed inspectors, the bureau developed a plan of utilizing authorized practicing veterinarians in this work. A regulation providing for this became effective July 1, 1919, and was later revised. A practitioner to be eligible for this service must first be recommended by the proper livestock sanitary official of the State

in which he resides and then be approved by the chief of the Bureau of Animal Industry. Following this plan 6,633 practitioners have been listed as authorized for interstate work. Under their supervision 210,250 cattle were tested during the year, and 3,360 reactors, or 1.6 per cent, were removed.

During the year 54,724 cattle were tested at public stockyards under regularly employed inspectors, and 1,417 reactors were removed. In accordance with the regulation requiring that a permit be issued for the interstate movement of known tuberculous cattle for immediate slaughter or for return movement to the original owner for breeding purposes, permits were issued covering 5,466 reactors for immediate slaughter and 107 for return to original owners.

#### METHODS OF TESTING.

In previous years the subcutaneous tuberculin test has been principally employed in testing animals for tuberculosis. Scientific investigation in recent years has developed the intradermic and ophthalmic methods of applying the tuberculin test. As practical experiments in the bureau's work demonstrated the value of these latter methods, the intradermic test was recognized March 1, 1920, as official under the accredited-herd plan, to be employed as the first test of herds in States where the State officials gave their approval. It has also been recognized for testing cattle for interstate movement to States whose officials accept certificates of that character. It is believed that this method, used in combination with the ophthalmic test or the subcutaneous test, will greatly expedite the work in a number of States where the inspectors have been unable to keep pace with the applications for testing.

#### TESTING IN THE DISTRICT OF COLUMBIA.

The District of Columbia is kept practically free from bovine tuberculosis as a result of work carried on in cooperation with the District health department continuously since 1909. During the past fiscal year 292 lots of cattle comprising 1,173 head were tested, and 3 reactors, or approximately one-fourth of 1 per cent, were removed. This low percentage affords a striking contrast with the 18.87 per cent of diseased cattle found in 1910. The 3 infected animals had been brought into the District on health certificates and later reacted to a retest. Of the 1,173 animals tested, 516 received the subcutaneous test alone, 294 the intradermic test alone, while 363 were tested by both the intradermic and subcutaneous methods. In addition 222 lots of cattle containing 425 head were tested for entry into the District of Columbia and 18 reactors were removed.

#### CONFERENCES ON TUBERCULOSIS.

A general conference on tuberculosis, arranged by State and Federal livestock sanitary officials, was held at Chicago on October 6, 7, and 8, 1919. A large number of interested persons attended, and the results were very beneficial to the progress of the campaign. The proceedings of the meeting were published in pamphlet form and widely distributed. It is planned to hold such conferences, some regional and some national, from time to time.

## STATISTICS OF THE YEAR'S WORK.

The following tables present a statistical summary of the testing and slaughter of cattle, indemnity paid, etc.:

*Summary of tuberculin testing.*

Class of work.	Cattle.	Reactors.	Per cent.
Accredited herds.....	695,364	28,616	4.12
Interstate testing:			
By authorized practicing veterinarians.....	210,250	3,360	1.60
By official veterinarians.....	54,724	1,417	2.58
Total.....	960,338	33,393	3.48

*Cattle slaughtered, appraised value, indemnity allowed, and salvage realized in work of tuberculosis eradication.*

State.	Number of cattle.	Average appraisal per head.	Total State indemnity.	Total Federal indemnity.	Average State indemnity per head.	Average Federal indemnity per head.	Average salvage per head.
Connecticut.....	553	\$88.96	\$22,032.48	\$10,765.67	\$39.84	\$19.45	\$29.54
Delaware.....	104	161.73	7,967.54	2,943.08	76.62	28.30	18.65
District of Columbia.....	6	100.00		117.50		19.55	39.16
Idaho.....	286	277.62	10,470.18	10,470.27	36.26	36.26	46.48
Illinois.....	773	323.00	30,622.18	30,622.18	39.60	39.60	57.57
Indiana.....	473	232.58	24,887.19	17,282.88	52.62	36.52	47.48
Iowa.....	1,714	296.58	88,245.01	62,168.17	51.48	36.28	48.13
Kansas.....	216	323.24	23,143.55	10,238.33	107.14	47.40	59.68
Kentucky.....	268	176.41	22,115.79	8,073.46	86.26	30.13	29.81
Maine.....	272	139.71	17,137.21	6,928.29	63.00	25.45	23.27
Maryland.....	541	102.90	10,895.58	10,895.58	20.14	20.14	42.66
Michigan.....	342	302.60	27,364.50	15,907.55	80.00	46.50	51.17
Minnesota.....	1,200	93.88	44,704.89	12,588.93	37.25	10.50	44.30
Missouri.....	252	27.41	9,677.92	9,677.82	38.40	38.40	13.47
Montana.....	634	96.05	47,274.49	14,256.15	74.56	22.48	19.52
Nebraska.....	593	285.32	23,015.67	23,015.67	38.77	38.77	46.80
New Hampshire.....	107	231.13	7,246.75	4,368.27	67.72	40.82	33.97
Nevada.....	1,138	77.32	25,083.50	14,853.12	22.00	12.17	22.96
New Jersey.....	215	313.26	15,571.30	7,676.76	72.42	35.71	53.80
New York.....	1,847	223.17	72,130.10	26,689.52	39.05	14.45	42.33
North Carolina.....	169	210.98	6,075.94	5,661.21	35.94	33.50	59.84
North Dakota.....	359	57.46	5,714.10	2,857.07	15.88	7.96	32.19
Oklahoma.....	477	207.36	39,872.15	18,298.02	85.68	38.56	40.09
Ohio.....	492	146.79	36,152.89	15,469.18	73.48	31.44	45.52
Oregon.....	259	180.40	10,428.54	8,036.40	40.24	31.02	40.64
Pennsylvania.....	953	265.40	53,289.44	36,625.87	56.93	38.42	44.75
Rhode Island.....	4	243.50	147.48	140.00	36.87	35.00	38.20
South Carolina.....	80	92.05	1,484.04	1,484.04	18.55	18.55	36.36
South Dakota.....	478	25.51	32,029.04	17,115.97	67.00	35.80	52.19
Utah.....	81	108.14	1,965.42	1,965.39	84.22	24.26	23.94
Vermont.....	2,995	101.12	143,987.15	78,072.66	44.73	26.06	16.68
Virginia.....	199	164.67	5,115.43	4,412.79	25.70	22.17	23.37
Washington.....	1,370	169.69	38,013.51	34,362.15	27.73	25.08	43.45
West Virginia.....	140	102.53	6,285.51	3,151.40	44.89	22.51	27.67
Wisconsin.....	1,114	232.54	24,140.41	24,139.73	21.67	21.67	44.08
Totals.....	20,704	178.37	934,237.18	551,331.08	45.12	26.62	38.76

## DIVISION OF HOG-CHOLERA CONTROL.

Activities in combating hog cholera were continued through the Division of Hog-Cholera Control, under Dr. U. G. Houck, chief, in cooperation with the regulatory authorities and the extension divisions of agricultural colleges in 34 States.



While the bureau has practically discontinued treating hogs in localities where the services of veterinarians are available, there are sections, particularly in the Southern States, where such service is not to be had, and in such districts bureau inspectors still render a certain amount of personal service in checking outbreaks of cholera. Laymen have been trained to administer treatment for cholera in these sections where the laws of the State permit. In the principal hog-raising States well supplied with veterinary practitioners the work has been of an advisory and supervisory character. Outbreaks of hog cholera reported by county agents, veterinarians, farmers, and others are investigated, so far as the available number of men will permit, diagnoses are made, and advice is given as to method of treatment, cleaning, disinfecting, etc. The work of veterinary practitioners in the application of serum and virus has been supervised as much as possible and faulty technique corrected. Where laws are adequate and enforced, infected farms are placed under quarantine until the herd has entirely recovered and dead animals have been properly disposed of and the premises cleaned and disinfected. The lack of attention on the part of swine owners to the cleaning and disinfection of premises following outbreaks of cholera is one of the many handicaps in the way of ultimate eradication.

During most of the year 140 veterinarians were assigned to the work against hog cholera. In the course of their activities 1,005 meetings were held, with an attendance of 62,144 persons; 3,037 demonstrations in the use of the serum treatment were given, in which 347,702 hogs were treated; 31,557 investigations were made, 10,963 autopsies held, 6,129 farms quarantined, 2,099 farms cleaned and disinfected, 46,125 farms visited, 200,034 personal interviews held, 472 persons trained in the application of the serum treatment, and 360,354 hogs were treated under the supervision of bureau veterinarians. There were reported to the inspectors in the field from various sources 9,788 outbreaks of hog cholera. With prompt attention and adequate cooperation the spread of infection from these original outbreaks was overcome.

A reduction in the appropriation for the work against hog cholera during the coming fiscal year has made necessary a considerable curtailment in the force of inspectors and the almost complete cessation of what were termed educational activities. The bureau is confronted with a difficult problem in endeavoring to hold the advantage already won and keep the contagion in check with a reduced force.

#### **PATHOLOGICAL DIVISION.**

The Pathological Division, under the direction of Dr. John S. Buckley, chief, has continued the scientific investigation of diseases of animals and the study of the poisoning of livestock by plants, and has examined viruses, serums, and other remedies for the treatment or prevention of various ailments in domestic animals.

#### **INFECTIOUS ABORTION.**

In seeking practical means of combating abortion disease of cattle, efforts have been continued along the lines of artificial immuniza-

tion. A living-organism vaccine has been exclusively employed, inasmuch as the results from inoculations of bacterins and serums during previous years have proved to be disappointing. Such a vaccine when used under purely experimental conditions in already infected herds has continued to give promising results. The single treatment of nonpregnant animals with this vaccine permits the convenient employment of the immunizing procedure, which is a highly desirable feature. Serological and bacteriological work has indicated that the subcutaneous injection of a living-organism vaccine usually produces but a temporary infection of the nonpregnant animal. This is seemingly explanatory of the immunity conferred as well as of the failures to obtain beneficial results when animals harboring abortion infection have been vaccinated. Abortion-free animals treated with a living-organism abortion vaccine during the nonpregnant stage have given evidence of possessing subsequently a resistance to abortion disease suggestive of that exhibited by animals which under herd conditions have acquired and fully recovered from abortion infection. Much routine work has been performed, consisting of the application of the laboratory tests to several hundred samples of blood serum from suspected cases. Correspondence has furnished a means of disseminating information regarding control measures to herd owners.

#### BOTULISM.

Further opportunities were afforded for the study of botulism. In cooperation with the Bureau of Chemistry considerable work was done in determining the toxicity and identifying the type of cultures of *Bacillus botulinus* recovered from olives, the consumption of which had caused fatal botulism in man. It was found that in every case the olives were infected with what is known as the type A organism. Experimental work showed that suspensions of *B. botulinus* spores heated to 80° C. to destroy the soluble toxin were capable of inducing typical botulism in guinea pigs when given in sufficiently large doses either by the mouth or subcutaneously.

A small flock of hens kept under back-yard conditions in the District of Columbia developed severe illness about 18 to 24 hours after eating the contents of a jar of spoiled home-canned corn. The whole flock succumbed within 48 hours. Bacteriologic examination of the crop contents of one of the dead birds revealed the presence of *B. botulinus* of the same type as the Nevin strain (type B). It produced a toxin having a minimum lethal dose for guinea pigs of 0.0001 cubic centimeter. Subcutaneous injection of 5 c. c. of the toxin produced fatal results in an adult fowl, and 10 c. c. given by the mouth to a large hen caused severe symptoms of botulism from which the bird recovered after about two months.

Sheep have been immunized against both type A and type B strains of *B. botulinus* toxin. The serum from these sheep in 1 c. c. doses has shown an ability to protect guinea pigs against about 10,000 minimum lethal doses of toxin. Some of the type A serum has been sent out for human cases of botulism and promising results have been reported following its use.

Some of the type A serum has been tried in cases of forage poisoning in mules, but sufficient data have not been gathered on which to

base definite conclusions as to its efficacy in this disease. In general, if serum is to be of any value it must be used in the very early stages of the disease or before the development of symptoms, and then, unless the type of organism responsible for the disease is known, a bivalent serum should be used.

#### OTHER RESEARCH WORK.

Microscopic examination of tubercular lesions in lymph glands of swine slaughtered at an establishment under Federal meat inspection revealed quite constantly the presence of acid-fast bacilli resembling tubercle bacilli. Many guinea pigs were used for inoculation tests, but in no instance did lesions of tuberculosis or any other disease develop. Cultures from the original material in one case developed into a tuberculosislike growth on hemoglobin-agar and Dorset's egg medium. With this culture slight glandular lesions and enlargement of the spleen were produced in guinea pigs, a local abscess in rabbits inoculated subcutaneously, and nodules on the peritoneum of hens and pigeons inoculated intraperitoneally. Other experiments on calves and hogs are in progress. Tuberculin manufactured from cultures of this bacillus gives positive results to intradermic tests in guinea pigs infected with the organism; it also produces death in such guinea pigs when injected intraperitoneally. Up to the present it can not be definitely announced that this organism is a type of tubercle bacillus.

Two outbreaks of specific edematous emphysema in hogs occurred within the last year on the same premises in the District of Columbia. In each instance the infection followed hog-cholera vaccination. From the local lesion there was recovered an anaerobic bacillus which corresponded quite closely in morphological, cultural, and pathogenic properties to the bacillus of Ghon and Sachs described by Köves in Hungary and Myer in this country. This organism lies intermediately between the blackleg bacillus and the malignant edema bacillus. The disease produced by the organism has been referred to as blackleg of swine and as specific gas phlegmon of hogs.

#### DIAGNOSIS OF DOURINE, GLANDERS, TUBERCULOSIS, AND RABIES.

The complement-fixation test has continued to be extensively employed in the diagnosis of dourine, 18,468 samples of blood serum having been tested, of which 257 gave positive reactions.

Cooperative work for the control of glanders in the various States was continued. The complement-fixation test was applied to 830 samples of blood serum forwarded by various State officials and practicing veterinarians, and 47 of these samples gave positive reactions.

Laboratory examinations have been made of selected tissues from 799 cattle in which no visible lesions of tuberculosis were found at time of slaughter, even though they had previously given positive reaction to the tuberculin test. Tubercle bacilli were demonstrated in 197 cases, while none could be found in the specimens from the remaining 602.

A marked reduction in the number of suspected cases of rabies submitted for examination was noted, the total number being 79 against 117 cases the year before. These cases came principally from



Maryland, Virginia, and West Virginia, numbering 51 cases, while those from the District of Columbia numbered only 28 cases. Of the 79 suspected cases a positive diagnosis was made in 43. The positive cases were 36 dogs, 2 cats, 4 cattle, and 1 hog. A considerable number of persons, as well as a number of animals, had been bitten by the affected animals.

#### EXAMINATION OF ARMY HORSES FROM OVERSEAS.

In cooperation with the Quarantine Division, diagnostic laboratory work was done on materials submitted from Army horses returned from overseas service, to exclude animals affected with infectious diseases. Samples of blood serum from all animals held in quarantine were submitted to the complement-fixation test for glanders and trypanosomiasis. All the animals were found to be free from glanders infection, while one was found to be infected with trypanosomiasis and was destroyed. Blood smears from all these animals were also examined microscopically at regular intervals for evidence of infection with piroplasmosis, but no evidence of this disease was found. By means of the toxin-antitoxin test one animal was found to be affected with ulcerative lymphangitis, a disease not known to exist in this country, and was therefore destroyed.

#### BLACKLEG VACCINE.

During the last year the demand for vaccine for immunizing cattle against blackleg did not equal the requirements of some previous years, yet 1,757,805 doses were distributed to stock owners free of charge.

#### BIOLOGICAL PRODUCTS.

Cooperating with the Division of Virus-Serum Control, which conducts regulatory work of supervising the commercial production of veterinary biological products, the Pathological Division has continued the testing of certain products and has carried on some research work in the field. During the year 218 samples, representing 42 different kinds of serums, bacterins, vaccines, and germ-free filtrates, were submitted for examination, and 48 of them were found to be unsatisfactory because of contaminations or lack of potency. There were also submitted for examination 1,024 cultures of organisms intended for use in the preparation of biological products, of which 226 were found to be unsatisfactory because of contaminations or atypical cultural characteristics.

The complement-fixation test has been regularly used in the examination of hemorrhagic-septicemia cultures and bacterins. The uniformly good results with so large a number of samples has proved its reliability to be unquestionable. Because of the good results obtained in this laboratory, several biological houses have adopted this procedure as a routine test for these organisms, and the good effects are already evident in their products.

Serums and similar therapeutic products are almost invariably filtered through bacteria-retaining filters before transfer to final containers, and frequently this step is preceded by filtration through kieselghur to remove coarse particles. As kieselghur and other

porous earths have marked powers of adsorption, some tests were made to determine whether such filtration is attended with loss of therapeutically valuable substances. When one sample of tetanus serum, one of tetanus plasma, and one of tetanus antitoxin were filtered through kieselghur and a Berkefeld type filter, chemical tests showed the adsorption of protein in amounts ranging from 7 to 35 per cent of the total. Guinea-pig inoculation tests on these same products showed no measurable loss of antitoxic units in the serum and plasma, but in the antitoxin the loss in potency ranged from 8 to 14 per cent of the total number of units. Similar experiments are in progress with diphtheria serum, plasma, and antitoxin. The extreme conservatism of certain manufacturers' statements of potency leads to the view that in many cases the potency of a product is not known, even approximately. A sample stated to contain "about 200" units of tetanus antitoxin was found to contain 500 per cubic centimeter.

Serological studies with several of the more important spore-bearing anaerobic microorganisms has shown that germ-free filtrates of these organisms will act as antigens in the complement-fixation test, in which an exceptionally wide range between the antigenic and anticomplementary units is obtainable. Promising results have so far been obtained in the identification and differentiation of the filtrates of these anaerobes. A paper reporting this work was contributed to the *Journal of Agricultural Research* (vol. 19, p. 513). Practical application of this phenomenon has been made in the determination of purity and specificity of the blackleg filtrates intended for immunizing purposes. Further work is being done with the filtrates of certain organisms.

#### EXPERIMENTAL STUDY OF ECHINACEA THERAPY.

In view of the wide use of echinacea in human and veterinary practice and the claims made regarding its efficacy in infectious and allied diseases, some laboratory experiments were carried out with various preparations of the plant. "Specific medicine echinacea," "fluid-extract echinacea," and "subculoyd inula and echinacea" were tested on guinea pigs for the prevention or treatment of tetanus, botulism, septicemia, anthrax, tuberculosis, trypanosomiasis, and poisoning by rattlesnake venom. In no case did it show any therapeutic or curative effect. A paper reporting these experiments was prepared for the *Journal of Agricultural Research*.

#### DISEASES OF POULTRY.

Quail disease was studied, and a form of protozoan organism known as a coccidium was found to cause it. As coccidiosis is successfully treated in fowls, the same method of treatment may be applied to quail disease. The results of the investigation were published.

Several outbreaks of rose-chaffer poisoning were diagnosed in carcasses of young chickens submitted to the laboratory. Extensive losses among chickens, generally attributed to other causes, result from eating rose chafers which invade certain sections of the country during the latter part of May, June, and early in July. A paper re-

porting this work was published in the Journal of the American Veterinary Medical Association (vol. 10, n. s., p. 692).

Considerable poultry material was received for examination and diagnosis. Correspondence regarding poultry disease continued heavy.

#### PATHOLOGICAL SPECIMENS.

As usual a large number of pathological specimens were received for diagnosis. Among those of special interest were five different specimens of skin and subcutaneous tissues of swine showing lesions characteristic of urticaria or so-called "diamond skin disease." One of the specimens showed more or less necrosis and sloughing of the skin, simulating in appearance the inflammatory phenomena of the skin resulting from freezing. From each of the specimens pure cultures of a small, slender organism, which proved to be similar in all cases, were obtained. The different strains of the organism were proved to be identical in their various biological characteristics with *Bacillus erysipelas suis*, the organism which causes erysipelas of swine in Europe. While it was not found possible to produce swine erysipelas with the organisms isolated from the subcutaneous lesions, this does not appear to be unusual, since European investigators have experienced difficulty in transmitting erysipelas to healthy swine.

#### AUTOPSIES ON WILD ANIMALS.

During the year 80 animals were received from the National Zoological Park for post-mortem examination. Of the 48 birds examined, 7 were affected with tuberculosis, 3 with anemia, 13 with enteritis, 3 with gastritis (impaction of the proventriculus), 1 with pyemia, 5 with septicemia (3 colon type, 2 staphylococcus), 1 with pericarditis, 1 with necrosis of the ceca, 2 with severe injuries, and 11 with undetermined affections. Of 31 mammals, 5 were affected with tuberculosis, 2 with pyemia, 10 with gastroenteritis, 1 with enteritis, 4 with pneumonia, 2 with colitis, 1 with cachexia, 1 with peritonitis, 1 with metritis, 1 with hepatitis and nephritis, 1 with disseminated tumors in lungs, and 2 with splenic tumor. The 1 specimen of reptile (boa constrictor) was affected with enteritis and parasitism of the lungs and intestines.

#### PLANT-POISONING OF STOCK.

Most of the field investigative work relative to poisonous plants has been conducted at the experiment station near Salina, Utah. Special attention has been given to the microscopic pathology of the animals affected by poisonous plants. The chemical and pharmacological examinations have also been conducted on a somewhat more extended scale.

A large number of plants have been under investigation, and what are considered final results regarding some of them have been obtained. The field work on the western sneezeweed (*Helenium hoopesii*) is nearly completed and a report on it has been prepared. The supposed poisoning of sheep by feeding on screenings of the seeds of sweet clover (*Melilotus*), the screenings consisting largely of immature seeds, led to experiments which proved the harmless character



of the seeds. Department Circular 87, giving the results of this investigation, was published. Several loco plants have been under investigation, and Department Circular 81 on *Astragalus tetrapterus* has been published. Some other plants have been definitely proved to be locoes, but the results are not yet ready for publication. A species of *Baccharis* occurring in parts of Arizona and New Mexico has been shown to be poisonous to livestock, and a preliminary notice in regard to it has been published in the Journal of the American Veterinary Medical Association (vol. 10, n. s., p. 430).

Field work has been done on the woody aster, which causes losses of sheep in Wyoming. Definite results have been obtained, but they are not yet in form for publication. Studies on *Asclepias galioides* (whorled milkweed) have been continued and two publications regarding it have been issued, namely, Department Bulletin 800, presenting the work in detail, and Department Circular 101, giving a brief statement of the results. Studies also have been conducted on the other species of whorled milkweed, and the results will be ready for publication in the near future.

A study of the rayless goldenrod (*Isocoma heterophylla*), which is common in the Pecos Valley of New Mexico and is popularly supposed to cause milk sickness of animals, has been undertaken. Experimental feedings of the seeds of the coffee-bean plant (*Daubentonia longifolia*) showed that they were very poisonous. Department Circular 82, calling attention to the poisonous properties of this plant and giving some of the main facts in regard to its toxic character, has been published.

A progressive decrease in the losses of animals on the western ranges is noted, due, without doubt, in part to the attempts of the Department of Agriculture to convey definite information to the stock people, and in part to the fact that the increased value of livestock has resulted in greater attention being paid to their proper care.

#### BRANCH LABORATORIES.

The branch pathological laboratories at Chicago, Omaha, and Denver have done an increased volume of work, consisting principally in making diagnoses of obscure cases arising in the meat inspection. They have made a large number of examinations of specimens from cattle slaughtered following their reaction to the tuberculin test, and have done some research work.

#### BIOCHEMIC DIVISION.

The Biochemic Division, under Dr. M. Dorset, chief, has continued its work, consisting chiefly of investigations concerning hog cholera, laboratory research work relative to meat products, studies of dips and disinfectants, and the preparation of tuberculin and mallein.

#### HOG-CHOLERA INVESTIGATIONS.

The research work on hog cholera has been carried out under three general projects, as follows: (1) Methods of producing immunity, (2) modes of spread of the disease, and (3) the cause of hog cholera, including related diseases.

## METHODS OF PRODUCING IMMUNITY AGAINST HOG CHOLERA.

The chemical studies of antihog-cholera serum have been continued, with the object of obtaining a better understanding of the effects of the various processes, particularly heat, upon the various constituents of the serum and to develop new methods or to perfect old methods for the refinement or concentration of the serum. During the year it has been found that heating clear serum or allowing the serum to stand for long periods of time in contact with phenol changes the relative proportions of the globulin in the serum, the proportion of the eu-globulins being increased by each of these factors. A similar study has been made on the defibrinated blood serum, but this work has not been completed.

Some years ago a method of removing blood cells from defibrinated hog's blood was devised, and this has led to the commercial production of clear virus. A very large volume of the defibrinated blood serum, however, is still produced. During the year studies of the properties and reactions of defibrinated blood, particularly old defibrinated blood serum which has been kept for some time in storage and in which the blood cells have undergone more or less disintegration, have been carried out. While no process for practical use can be recommended at this time as a result of this work, the work has proceeded far enough to show that hemoglobin in old hog-cholera serum combines with chloroform so that the hemoglobin is rendered completely insoluble and may be removed by centrifugalization. The clear serum thus obtained amounts to approximately 64 per cent of the original volume, and it may be heated without coagulation, which would be impossible before the hemoglobin was removed.

With the object of producing an effective and safe vaccine against hog cholera an extensive series of experiments was carried out with vaccine prepared by a new and original method. Work in previous years having shown that ammonia ( $\text{NH}_4\text{OH}$ ) in quite low concentration (0.125 per cent) destroyed the virus of hog cholera within a comparatively short time, the defibrinated blood from pigs sick of cholera was mixed with ammonia in different concentrations and allowed to stand for varying periods of time under different conditions of temperature. Pigs were then injected with varying amounts of this ammoniated virus at varying lengths of time after its preparation, the injections being repeated at intervals of a week, and the treated pigs were later exposed to hog cholera by virus injection or by association with sick pigs. For the most part the injected pigs remained well, but in isolated cases in the early experiments hog cholera developed as a result of the vaccine. While the results of these experiments were too irregular to permit the use of such a vaccine in practice, there was evidence of the production of considerable resisting power in the pigs, and this line of work appears sufficiently promising to warrant its continuance.

The experiments mentioned, in last year's report, to determine the duration of immunity against hog cholera following simultaneous inoculation of young pigs, have been completed and the results published in the *Journal of the American Veterinary Medical Association* for May, 1920, volume 10 (n. s.), page 176. These experiments, although few in number, indicate that the simultaneous inoculation of young pigs confers a lasting immunity.

## MODES OF SPREAD OF HOG CHOLERA.

The investigation of the rôle of insects in the transmission of hog cholera was continued. The experiments dealt principally with stable flies, house flies, and gnats.

In the work with gnats, the *Simulium* (buffalo gnat) was the insect used, as that is the most common gnat in central Iowa, where the experiments were carried out. Valuable cooperation was given by the Bureau of Entomology. The gnats were allowed to bite pigs affected with cholera, and later a number were allowed to bite non-infected pigs. In no case was it possible to transmit cholera through the bite of the gnats.

Considerable work was done to determine the length of time the virus of hog cholera survived in the body of house flies after they were infected by feeding on hog-cholera blood. The infectiousness of the flies was tested at intervals after feeding by injecting the macerated flies subcutaneously into susceptible pigs. It was found that the time during which the virus remained alive in the body of the house fly depended very largely upon the temperature at which the flies were kept. At low temperatures the virus survived for some days, while at summer temperature of the air its virulence was lost after 24 to 48 hours. In other experiments, house flies which had been infected with cholera and killed were placed in pens with susceptible pigs. Also live house flies, infected by feeding on diseased blood, were liberated in screened pens containing susceptible pigs. In still other experiments, flies hatched from eggs deposited by flies which had fed on hog-cholera virus were ground up in salt solution and injected into susceptible pigs. In none of these experiments was it possible to transmit hog cholera except when flies which had fed on cholera blood were ground up and injected subcutaneously into the susceptible pigs.

Attempts were made to transmit hog cholera by causing stable flies, which had previously bitten pigs affected with cholera, to bite susceptible pigs. In some cases the same pig was bitten by a number of different infected flies. Cholera was transmitted only in exceptional cases, and this when the susceptible pig was bitten by a considerable number of flies within a very short time after the flies had fed on the sick pig. A repetition of the work previously done by allowing a large number of stable flies to feed on sick pigs and then liberating them in clean, screened pens with susceptible pigs always gave negative results. Stable flies hatched from eggs deposited by infected flies were found to be free of the virus of hog cholera by macerating them and injecting them into susceptible pigs.

Considering these experiments in connection with those of previous years, we are led to the conclusion that neither stable flies nor house flies are important factors in the dissemination of hog cholera. The experiments with gnats have been much less extensive, but there is at least no indication that the buffalo gnat is capable of transmitting hog cholera.

## CAUSE OF HOG CHOLERA AND RELATED DISEASES.

A scientific worker in a commercial institution having reported that he had cultivated the virus of hog cholera in pure culture, a



careful study of this subject was made. After practical laboratory experiments, together with tests of supposed cultures on pigs, the conclusion was reached that the claims were not established, it being impossible to affirm from a microscopic observation that any organisms had grown, and likewise impossible to produce the disease with the cultures when care was taken to make a sufficient number of subcultures to avoid any possibility of producing disease with the virus with which the cultures were started.

Additional data were gathered concerning the minimum fatal dose of the blood of pigs sick of cholera. Defibrinated virus blood was diluted with water or salt solution and injected subcutaneously into susceptible pigs in amounts equivalent to one one-thousandth, one three-thousandth, and one five-thousandth of a cubic centimeter of the blood. All the pigs contracted hog cholera. It is probable that the minimum fatal dose of blood from a pig suffering from acute hog cholera is considerably less than one five-thousandth of a cubic centimeter.

A few experiments were undertaken to compare the virulence of hog-cholera defibrinated blood prepared with one-half per cent phenol with that of clear virus and a filtered virus preserved in the same manner and obtained from the same blood. The samples were kept at room temperature ranging from 50 to 60° F. Pigs were injected at the end of 30 days and 60 days after the preparation of these different kinds of virus. All the injected pigs contracted hog cholera. A number of the pigs were inoculated with hog-cholera serum, some receiving at the same time the defibrinated blood virus, others the filtered virus, and still others the ordinary clear virus not filtered. These pigs are being held in order to determine whether a lasting immunity is conferred by these different injections.

The study of diseases of hogs which are related to and which may be confused with cholera has been continued. There are two different affections of pigs in the Middle West, and perhaps in other parts of the country, that may be mistaken for hog cholera and are of economic importance. One is commonly called necrotic enteritis, so called on account of the severe inflammatory condition observed in the intestines of the affected pigs. Pigs affected with this disease were procured and efforts were made to transmit it to others. In two instances it was possible to transmit this disease to healthy pigs by association and by feeding viscera of affected pigs. It was found, however, that in order to communicate the disease by association it was necessary to allow the pen to become very filthy. It appears that this disease, to a considerable extent at least, arises from bad sanitation and filth. When infected pigs were removed from the insanitary conditions under which they had been kept and placed in clean quarters and given proper food, as a general rule they made progress toward recovery.

The second disease, which is met with even more commonly than necrotic enteritis, is the so-called "flu" of hogs. This condition appears as a herd disease. A large number of the pigs appear to be extremely sick within a very short time and there is marked evidence of pulmonary involvement. As a rule the disease runs a rapid course and the most of the herd soon return to normal. The death rate is low, probably not more than 2 per cent. Efforts were made to

propagate this disease on our experimental farm, without success. Several samples of material from affected hogs in six different herds were obtained and healthy pigs were injected with it. In no case was it possible to communicate the disease to healthy pigs by these blood injections. The cause of the trouble is not yet established. It is interesting, and perhaps suggestive, to note that so far no disease, with the exception of hog cholera, which is prevalent among hogs in this country, has yet been found which can be regularly transmitted by the subcutaneous injection of blood from infected animals.

An extensive series of experiments with bacterins, particularly bacterins prepared from *Bacillus suispestifer* and *B. suissepticus*, was begun. A number of different strains of each of these organisms have been procured and the testing of these bacterins in different ways is now in progress.

A large number of samples of hog-cholera virus and antihog-cholera serum have been examined during the year for the Division of Virus-Serum Control. These examinations have shown that a very large proportion of the commercial serums contain considerable numbers of bacteria, while many samples of hog-cholera virus are likewise contaminated, though, as a rule, to a much less extent than the serum. No pathogenic bacteria have been demonstrated in either product.

#### DIPS AND DISINFECTANTS.

The laboratory work on dips and disinfectants has followed the same general lines as in previous years. A total of 180 samples of dips and disinfectants and miscellaneous materials was received and analyzed. During the calendar year 1919 there were sent to inspectors in the field 1,231 test outfits for arsenical dips, and supplies sufficient to make 638,000 field tests for arsenic; 31 test outfits for lime-and-sulphur dips, and sufficient material to make 14,800 tests of such dips; 24 outfits for testing nicotin dips, and supplies sufficient to make 6,200 field tests for nicotin; a total of 1,286 new test outfits and supplies for 659,000 tests.

In last year's report it was stated that the research work of the dip and disinfectant laboratory had developed the fact that soy-bean oil or the fatty acids derived therefrom could be used with advantage as a substitute for linseed oil in the manufacture of saponified cresol solutions. As a result the regulations governing official dipping and disinfecting operations were modified to permit the use of soy-bean oil or fatty acids derived therefrom. In continuation of this work it was found that three-fourths of the vegetable oil may be replaced by rosin, which is very much cheaper. This use of rosin does not change any essential property of this disinfectant but improves it in some respects. The results of this work were published as Department Bulletin 855.

A new method for determining phenol and certain of its homologs was developed, and the results of this work were published in the *Journal of Industrial and Engineering Chemistry* (vol. 12, p. 568). A second paper dealing with other phases of this work has been prepared.

An investigation of the germicidal value of some of the chlorin disinfectants was completed and the results embodied in an article for the *Journal of Agricultural Research*. This work led to the

conclusion that while the chlorin disinfectants have a very valuable place in the treatment of wounds and the purification of drinking water, they do not seem to be well suited for general disinfection, because the organic matter which is always present in large quantities quickly combines and renders the chlorin inert, and because chlorin is injurious to metals and fabrics. The action of the chlorin disinfectants was also tested on different disease-producing micro-organisms.

A comparative study of 15 samples of 6 brands of bacteriologic peptone showed that these peptones varied very greatly in composition and that some of the peptones on the market were of such composition that a typical culture of *Bacillus coli* gave negative reactions for indol when those particular peptones were used in the culture medium. This work indicates that it is advisable to test each new lot of peptone used in order to determine its suitability for indol production. A test of the peptone for the presence of tryptophane will usually show whether any given sample of peptone is suitable for indol production.

#### RESEARCH WORK ON MEATS AND MEAT FOOD PRODUCTS.

Chemical research on meats and meat food products has consisted chiefly in a study of the composition, nutritive value, and wholesomeness of edible viscera from meat food animals.

Thus far a chemical study of the livers of mature oxen and of calves has been made. In addition to the usual proximate analysis of this tissue, the percentage of each of the important mineral constituents has been determined. A discussion of the results is reserved until similar work with sheep and hog livers has been completed.

The antineuritic properties of beef and calf liver were investigated by feeding the dried liver in conjunction with polished rice to pigeons. The results indicate that calf liver has a lower antineuritic value than beef liver, though this difference may have been due to lower average vitality of the pigeons used in the test with calf liver. Additional experiments are planned to test the antineuritic value of liver as well as other edible viscera from meat food animals.

#### TUBERCULIN AND MALLEIN.

There was supplied to Federal, State, county, and city officials 5,517,040 cubic centimeters of tuberculin for the subcutaneous testing of cattle for tuberculosis. In addition 38,268 ophthalmic tuberculin disks, 20,250 doses of liquid ophthalmic tuberculin, and 132,420 doses of intradermic tuberculin were produced. The total output of tuberculin represents an increase of considerably more than 100 per cent over that of the preceding year.

The success obtained with ophthalmic tuberculin disks, which were first produced in these laboratories, in testing cattle for tuberculosis, has made it necessary to provide additional equipment and a specially constructed room in which the humidity can be regulated. This is now practically complete and makes possible a large increase in the quantity of ophthalmic tuberculin that can be produced.

The quantity of mallein prepared and distributed for the diagnosis of glanders was 215,580 doses, as compared with a total of 2,930,810 doses the preceding year. This great decline is due to the



fact that it is no longer necessary to supply the War Department, which required large quantities during the war.

The tuberculin and mallein prepared and distributed by the laboratories during the fiscal year could not possibly have been purchased on the market even under the most favorable circumstances for less than \$75,000. In addition to this very considerable saving in money the bureau has been able to assure the purity and strength of these products used in its official testing for the eradication of tuberculosis and glanders.

#### OTHER WORK.

The assistant chief of the Biochemic Division is a member of the Insecticide and Fungicide Board and has given a large part of his time to the work of that board. In its cooperative work with the board the division analyzed 123 samples of insecticides intended for use on domestic animals, and 82 of the preparations were found to be misbranded or adulterated. The infractions of the law were for the most part technical errors which resulted apparently, as a rule, from ignorance of the law.

#### ZOOLOGICAL DIVISION.

The investigation of parasitic diseases of animals and the study, collection, and determination of animal parasites have been continued in the Zoological Division under Dr. B. H. Ransom, chief.

#### ROUNDWORMS OF SHEEP.

The principal experiments at the bureau farm near Vienna, Va., were designed to test the possibility of rearing lambs to marketable size without loss from stomach worms by changing them every three weeks during the grazing season to fresh pasture (forage fields on which a crop had been grown since their previous occupancy by sheep, and which had not been occupied by sheep since the preceding autumn). Shortly after lambing the ewes were dosed with copper-sulphate solution. The ewes and lambs were kept together in stables until the flock was turned out to pasture and thereafter also at night. One lot of lambs was pastured with the ewes, the other separately. The latter, however, were turned back into the stable with the ewes during a portion of each day for nursing as well as being stabled with them at night. Both lots of lambs were dosed with copper-sulphate solution when weaned, and both were thereafter kept entirely separate from the ewes, but were moved to fresh pasture at the same intervals after weaning as before; that is, every three weeks. There was no loss among the lambs that were pastured with the ewes. They made a stronger growth than the other lot, although they did not escape considerable infestation with stomach worms. The lambs that were pastured separately from the ewes became only very slightly infested with stomach worms. Their failure to make the growth that the others did is probably to be attributed to the interference with nursing involved in keeping them separated from the ewes a considerable portion of each day.

Old sheep and yearlings, as in former years, have been kept in good condition without special precautions as to the presence of

stomach-worm infection in the pastures (forage fields) by monthly treatments with copper-sulphate solution during the summer season. The question of the ultimate effects of these treatments upon the health of the sheep is still under investigation.

In connection with the experiments on roundworms, investigations have been carried on concerning the question of preventing tapeworm infestation. These investigations are still incomplete, but results thus far obtained indicate that eradication of tapeworms from small flocks of sheep can be accomplished without a great deal of trouble or expense.

#### ROUNDWORMS OF HOGS.

Field work on the problem of preventing losses from roundworms (*Ascaris*) among young pigs has been carried on in McLean County, Ill., where about 3,500 pigs on 20 farms are under observation. The following method of management has been employed: Before farrowing time all loose litter is removed from the farrowing pens and the pens are thoroughly scrubbed with boiling water and lye. About a week or 10 days before the sows are expected to farrow, their udders are thoroughly cleaned to remove any adherent dirt and the sows then placed in the clean pens. As soon as practicable after farrowing, the sows and pigs are removed to clean pasture. Small sheds or houses, which are moved occasionally to new locations in the pasture, are provided as shelters.

This method is designed to minimize the chances of roundworm infection during the first few months of life, during which time it has been found by investigations recorded in previous reports that pigs are most susceptible to and most likely to suffer seriously from infection. By observing special precautions during this time, as indicated above, the pigs can be tided safely over a critical period in their life, so far as concerns parasitic infection, and reared to an age when they are less likely to be injuriously affected by roundworms. The results have been very satisfactory in those cases in which the method was carefully followed, and on farms where in former years considerable loss was experienced among young pigs by death and stunted growth there has been practically no loss the present year. The field investigations will be continued in order, if possible, to establish a simple, practicable procedure in the management of hogs, that can be depended upon to give uniform results in preventing losses from roundworms.

In connection with the question of destroying eggs of *Ascaris* some observations have been made as to their thermal death point. It has been found that eggs in early stages of segmentation when placed in hot water may survive two minutes' exposure to a temperature of 60° C., but that under the same conditions eggs that have reached the infective stage die after one and a half minutes' exposure.

Further experimental work has been done with reference to *Ascaris* infection in sheep. A lamb fed with the eggs of *Ascaris suum* when a few days old was killed 111 days after feeding, and was found to harbor 6 ascarids 7 to 10 centimeters long. Another lamb that was similarly fed at the age of 4 weeks and killed 82 days after feeding was found free from ascarids. Three other lambs, about 6 months old, have been fed with eggs of *Ascaris suum*, all of them showing symptoms of pneumonia a few days later. *Ascaris* larvæ were

found in the lungs of one killed 8 days after feeding; the other two are being held for further observations.

Department Bulletin 817 and some minor publications on *Ascaris* were issued during the year.

Several experiments have been carried out relative to the mode of infection of pigs with lungworms (*Metastrongylus apri* and *M. brevivaginitus*). Pigs ranging in age from 4 days to about a month old were fed larvæ of lungworms from cultures ranging from 17 to 35 days old. In all cases the results were negative.

#### TREATMENT AND CONTROL OF EXTERNAL PARASITES.

**HOG LICE AND HOG MANGE.**—From experimental work and trials under actual field conditions, crude petroleum has been found to be the most efficacious remedy for lice and other external parasites of hogs, one dipping being sufficient to eradicate lice and sarcoptic mange. Follicular mange is benefited by repeated dippings in crude petroleum, but is not always eradicated in advanced cases. Crude petroleum may not only be used in dipping vats but also may be economically and effectively applied during warm weather by means of wallows. It was the only remedy among a large number tested that was found fully satisfactory for use in hog wallows. In the treatment of sarcoptic mange, lime-sulphur and arsenical dips have been found to be efficacious if four dippings are given at intervals of 6 or 7 days. Directions for the control and eradication of hog lice and hog mange are given in Farmers' Bulletin 1085, which is based upon the results of the investigations mentioned above.

**SARCOPTIC MANGE OF HORSES.**—Investigations thus far carried out indicate that repeated applications of lime-sulphur dip or crude petroleum are effective in eradicating sarcoptic mange of horses in ordinary light cases, but that in advanced cases successful results are difficult to obtain.

**OX WARBLER.**—Experimental work on the difficult problem of controlling ox warbles has been continued with reference both to range cattle and cattle confined in small inclosures. In the case of the latter various remedies are being applied to the animals by spraying, and in the case of the former by means of wading tanks, through which the cattle have to pass in order to reach their watering places. The results can not be determined until later.

**SCREW WORMS.**—Among inexpensive remedies tried in the treatment of wounds infested with screw worms, gasoline has been found to be the best, although not entirely satisfactory.

#### TRICHINOSIS.

In order to facilitate the supervision of the various kinds of pork products prepared customarily to be eaten without cooking and those that are cooked in meat-packing establishments under Federal inspection, the following classification of sausages of kinds prepared customarily to be eaten without cooking has been tested at the Chicago station and found to be satisfactory.

*Class A.*—Sausages or chopped meats that contain no pork except pork fat or frozen trimmings (that is, trimmings that have been



held at a temperature not higher than 5° F. not less than 20 days). This class is released from further special supervision after stuffing.

*Class B.*—Sausages or chopped meats that contain lean fresh pork and that are to be held under supervision after stuffing during the process of drying (20 to 25 days) in the drying room.

*Class C.*—Sausages or chopped meats that contain lean fresh pork and that are to be subjected to sufficient heat after stuffing to destroy the vitality of any trichinæ that may be present.

It has been found at Chicago that this method of classification renders the task of supervising the preparation of such sausages much simpler, and it is recommended for general adoption at all bureau stations, especially at those stations where from time to time different inspectors are assigned to the same department of an establishment. Any inspector can then readily determine what further processing is necessary in order to conform to bureau requirements in the case of any given lot of product in course of preparation in the department to which he is assigned.

During the year a report of investigations on the effects of heat on trichinæ was published in the Journal of Agricultural Research, and Department Bulletin 880, on the effects of pork-curing processes on trichinæ, was in the final stages of printing at the close of the fiscal year. A report of the effects of X-rays upon trichinæ has also been prepared for publication.

#### MISCELLANEOUS INVESTIGATIONS ON ANIMAL PARASITES.

Investigations on the possible relations between swamp fever in horses and intestinal parasites, in cooperation with the Health of Animals Branch, Canadian Department of Agriculture, have been continued. The investigations on the gapeworm of chickens have been continued.

It has been discovered that a small roundworm (*Cooperia punctata*) which is of common occurrence in the small intestine of cattle, especially in the southern part of the United States, has the habit, not previously recognized, of penetrating into the wall of the small intestine, where it causes considerable disturbance in the tissues and brings about an accumulation or proliferation of lymphoid elements, the lesions often being noticeable through the serous coat of the intestine as small yellowish spots either isolated or arranged in groups. The upper portion of the small intestine only is involved so far as yet observed. In affected portions of the intestine the wall is usually thickened. It is not unlikely that this small and inconspicuous parasite, which is often present in the lumen of the intestine in enormous numbers, may prove to be an important factor in the losses caused by internal parasites of cattle.

A study of the life history of the hookworm of cattle (*Bunostomum phlebotomum*) is in progress. The investigations concerning toxic substances in parasitic worms have been continued. The hemolytic substances in *Ascaris* have been found to be completely soluble in alcohol, thus disproving the view that fatty acids in the body of *Ascaris* are responsible for their hemolytic action. Hemolytic substances have been discovered in the hookworms of cattle (*Bunostomum phlebotomum*) and of dogs (*Ancylostoma caninum*), and in whipworms (*Trichuris* spp.), but as yet no toxic substances have

been isolated from stomach worms (*Hæmonchus contortus*). The fringed tapeworm of sheep (*Thysanosoma actinioides*) has been found to contain hemolytic substances, but none have been found in tapeworms of the genus *Moniezia*.

During the year 639 fecal samples from imported dogs were examined for the presence of parasites likely to be injurious to livestock. Of these, 189 samples showed evidence of parasites. *Tania* eggs were found in 51 cases, *Dipylidium* eggs in 14 cases, and *Diphyllbothrium* eggs in 2 cases. One case of *Echinorhynchus* was found.

A study of the internal parasites of Alaskan foxes was made for the Bureau of Biological Survey and a report published.

Publications relating to parasites, that have been issued during the year or were in press at the close of the year, not elsewhere mentioned in this report, include papers on the toxins of parasites, stomach worm, parasites of sheep (Farmers' Bulletin 1150), gape-worm, parasites of southern livestock, a new genus and 5 new species of flukes, roundworms of the genus *Nematodirus*, pork measles, carbon bisulphid as an anthelmintic, parasites found in imported dogs, parasites of man, parasites of vertebrates transmitted by insects, and the portion of the Index-Catalogue of Medical and Veterinary Zoology relating to nematodes.

#### MISCELLANEOUS DIVISION.

The Miscellaneous Division, of which Dr. A. M. Farrington is chief, has continued its work relating to the personnel of the bureau and to veterinary education.

##### BUREAU PERSONNEL.

At the beginning of the fiscal year there were 4,821 persons in the employ of the bureau. During the year there were 1,472 additions, made up as follows: Appointments, 1,343; transfers from other branches of the Government service, 45; reinstatements, 84. During the same period there were 2,008 separations from the service, as follows: Resignations, 1,075; deaths, 39; transfers from other bureaus or departments of the Government, 26; removals for cause, 4; all other separations, 864. At the end of the fiscal year the bureau personnel numbered 4,285, a decrease of 536 from the number at the beginning of the year. The large number of resignations is due to the fact that many of the appropriations were greatly curtailed by the last Congress and the bureau was unable to employ as large a force as formerly.

During the year 16 civil-service examinations were requested, and subjects and weights were furnished to the Civil Service Commission.

##### VETERINARY EDUCATION.

For years the bureau has felt the necessity of procuring for its inspection force veterinarians with a broad basic education. This is particularly true of inspectors engaged in public work which is new to a community and where they meet the leading men of the locality and must make a good impression if the work is to be successfully accom-

plished. Several years ago the department, in cooperation with the Civil Service Commission, formulated regulations prescribing the course of study to be followed in order for a veterinary college to be accredited and to have its graduates eligible for the civil-service examination for veterinary positions in the bureau. The educational standard has been progressively raised. During the year just passed the entrance requirements at accredited colleges have been still further raised to four years' high-school education, or 14 units. It is believed that this action will not only improve the efficiency of the veterinarians to be selected for employment in the bureau in the future but will raise the standard of education of the veterinary profession generally.

There are now 16 accredited veterinary colleges, of which 11 are State colleges with a veterinary department, 3 are private veterinary colleges, and 2 are agricultural colleges that have raised their courses of study from two years to four years and become fully accredited. Nine foreign veterinary colleges are on the accredited list. During the year the College of Veterinary Science of the University of the Philippines, at Manila, has been added to the list. Two agricultural colleges with a two-year course are accredited.

The total number of freshmen enrolled in all veterinary colleges for the session beginning in the fall of 1919 was 352, against 264 for the preceding year. The combined attendance at all veterinary colleges was 1,265, against 1,114 for the preceding year. The number of graduates was 371, against 214 for the preceding year. There were enrolled at the accredited agricultural colleges 49 students, of which number 4 were graduated from a four-year course.

The problem which now confronts those concerned in veterinary education is to adapt this education to the new conditions. Formerly the bulk of the income received by veterinarians in active practice was derived from the treatment of horses. Now that horses are being supplanted to a considerable extent by motor transportation, the veterinarian, to gain a livelihood, must devote his attention to other farm animals. Economic conditions have also made it worth while to give more veterinary attention to cattle, sheep, hogs, and poultry. The veterinary schools must adapt their courses of study to these new conditions.

#### OFFICE OF VIRUS-SERUM CONTROL.

The supervision of veterinary viruses, serums, antitoxins, etc., under the law of 1913 was continued by the Office of Virus-Serum Control, in charge of Dr. D. I. Skidmore. This work consists primarily of the issuance of licenses to establishments for the manufacture of veterinary biological products for sale in interstate commerce, and includes also the inspection of these establishments as to sanitary conditions and methods of production, the supervision of production, the testing of products, and the issuance of permits for the importation of such products from abroad. The object of the supervision is to assure the potency and harmlessness of this class of remedies.

During the year 135 licenses were issued to 93 firms for the preparation of 177 products of 69 general classes. Six licenses were can-



celed and 5 suspended, the latter for violations of the department's regulations. Fifty-eight of the licensed establishments produced only antihog-cholera serum and hog-cholera virus, 29 produced other products only, while 6 produced both classes of products. To supervise these establishments and products the bureau maintained 17 stations and 42 substations in 58 cities and towns in 20 States.

Serum and virus for the prevention of hog cholera form a large part of the volume of products supervised. The production of anti-hog-cholera serum amounted to 525,043,761 cubic centimeters, of which 5,057,120 cubic centimeters was destroyed as unfit for use, and in addition 3,557,120 cubic centimeters of blood was destroyed when collected, on account of disease or other conditions existing in the animals from which it was collected. The quantity of simultaneous virus produced was 22,838,784 cubic centimeters, of which 1,102,645 cubic centimeters was destroyed as unfit for use, and in addition to which 330,331 cubic centimeters of blood was destroyed when collected. The production of hyperimmunizing virus was 114,180,172 cubic centimeters, of which 271,460 cubic centimeters was destroyed as unfit for use, and in addition to which 7,719,425 cubic centimeters of blood was destroyed when collected. To determine the potency and purity of the serum and the purity of the virus 7,770 tests of the former and 1,228 of the latter were made. There were inspected and admitted to the premises of licensed establishments for use in the production and testing of the serum and virus 314,706 hogs and 2,918 calves, and 24 hogs and 1 calf were rejected. In subsequent operations 19,323 additional hogs were rejected.

During the year 866 subcultures involving 1,037 strains of organisms used in the production of licensed products were collected and submitted for laboratory examination. Of the strains, 800 were found to be satisfactory and 237 unsatisfactory.

#### EXPERIMENT STATION.

The work of the Experiment Station at Bethesda, Md., in charge of Dr. E. C. Schroeder, superintendent, has consisted mainly of investigations made both independently and in cooperation with other divisions, concerning infectious diseases of domestic animals, and the provision of facilities for other divisions to make observations on animals under normal farm and field conditions.

#### ABORTION DISEASE.

Studies concerning the etiology of infectious abortion disease of cattle, which have been in progress several years, were continued. The results are quite encouraging, as they indicate that much can be done to reduce losses by the use of relatively simple measures directed against the dissemination of the microorganism on which its occurrence primarily depends. Many careful tests have been made to determine through what channels the microorganism leaves the bodies of infected cattle, and only three have been definitely proved, namely, the reproductive organs of cows at and for a short period of time after a parturition or an abortion, the udders of infected cows for a period of time that may vary from a few days to seven or eight years, and the discharges from the reproductive organs of infected bulls. It has also been conclusively shown that the easiest natural

way to infect a cow with this disease is to permit her to ingest abortion bacilli. Service by an infected bull has failed to transfer the disease in our tests. While the unguarded and promiscuous use of infected bulls is not recommended, the results of our experiments give no indication that the bull, if kept in a special pen and permitted to serve cows only on neutral ground, plays any part in the spread of infectious abortion disease. It therefore appears that bulls owned by associations, provided the precautions indicated are observed, are safe in this respect.

Some attention has been given also to the influence of abortion disease on the fertility of the bull, but no conclusive results have yet been obtained.

As abortion among hogs, due either to the same bacillus that attacks cattle or to other causes, is evidently increasing in frequency in several portions of the country, work on this subject has been undertaken and will be continued.

#### TUBERCULOSIS AND MISCELLANEOUS WORK.

Nothing radically new regarding tuberculosis was developed during the year. Several investigations which have been in progress several years have been continued and are nearing completion.

The tests for potency and purity of tuberculins manufactured and sold under Government license proved all the tested products to be satisfactory. There seems to be a general tendency for commercial tuberculin to be superpotent rather than subpotent. While this is a better condition than the reverse would be, a definite, unvarying potency is preferable.

In view of the finding of tubercle bacilli in cream cheese a few years ago, tests of this product have been continued. During the year 100 samples were tested, with negative results in all cases, thus indicating that the bureau's previous work has led manufacturers to adopt effective means to prevent contamination.

Tests with milk from the local supply show that raw market milk occasionally is contaminated with the abortion bacillus and more rarely with the tubercle bacillus. A comparison between guinea pigs injected respectively with commercially pasteurized and raw market milk shows that a very much larger proportion die from the latter than from the former. Such results show conclusively that commercial pasteurization, though still lacking official supervision, is a commendable public-health measure.

A large number of small experiment animals were raised at a cost much lower than current market values. Various tests were made with pathological material suspected to contain the virus of infectious diseases. Biological products of various kinds were supplied the other laboratories of the bureau. Every available portion of the station's land was kept under intensive cultivation to obtain forage for the experiment animals.

#### EXPERIMENTS IN LIVESTOCK PRODUCTION IN CANE-SUGAR AND COTTON DISTRICTS.

At the Iberia Experiment Farm, Jeanerette, La., experiments and demonstrations with horses, mules, beef cattle, dairy cattle, and hogs are conducted for the purpose of bringing before the farmers the

value of livestock production in the cane-sugar and cotton districts. This work, which was begun in 1914, is carried on under the direction of a committee consisting of representatives of the Bureau of Plant Industry, the Bureau of Animal Industry, and the Louisiana State Experiment Station.

During the year 330 acres of land were used for feed production. At the close of the fiscal year there were on the farm 7 brood mares, 6 mature mules, 15 mules bred at the station, 45 dairy cattle, 130 beef cattle, and 121 hogs.

The application of barnyard manure to the fields has continued to increase the yields of crops, and preliminary experiments begun in 1919 indicate that commercial fertilizers have an important use in increasing the productivity of the unproductive soils. Cottonseed meal applied at the rate of 200 pounds to the acre increased the yield of corn 8.03 bushels an acre and gave a net profit of \$6.41 over the unfertilized plots. An application of 200 pounds of cottonseed meal and 100 pounds of acid phosphate to the acre increased the yields of corn 8.88 bushels an acre with a net profit of \$6.36 per acre. Acid phosphate applied at the rate of 100 pounds to the acre increased the yield of corn 4.97 bushels per acre and returned a net profit of \$6.54.

The animals were inoculated twice during the year for anthrax, a disease prevalent in this section, and no outbreak occurred. Forage poisoning was also successfully combated by keeping the animals off of pasture when poisoning was prevalent.

Additional data have been obtained in the experiment to determine the maintenance cost of a beef breeding herd and the cost of producing beef breeding heifers and feeder steers. The average cost of raising a heifer calf to 2 years of age was \$52.68, and to the age of 30 months \$74.03, while the average cost of a feeder steer was \$38.31 at 1 year of age, and \$56.24 at 2 years. These steers were then fattened, and the average total cost per steer when shipped to market was \$110.12. As the net selling price per steer was \$118.63, the net profit on each steer was \$8.51. The fourth year's results of feeding experiments with beef cows showed the yearly cost of maintenance to be \$44.85.

During the last three years experiments have been under way to test the relative values of the available silage crops for fattening steers when supplemented with cottonseed meal and other concentrates. During the last fiscal year seven lots of steers were fed for 112 days on various silage crops suited to the coastal region, supplemented with cottonseed meal and molasses. Five kinds of silage were fed with the same amount of the supplemental feeds, and in addition other lots of sorghum and Japanese-cane silage were fed with a large amount of supplements, namely, about 10 per cent more cottonseed meal and more than twice as much molasses. Those lots of sorghum and Japanese cane which were fed with the regular amount of supplements are here designated as No. 1, and the others as No. 2. Sorghum silage No. 2 produced the greatest average daily gain per steer, 3.13 pounds, followed by the others in the following order: Corn, sorghum No. 1, Egyptian wheat, corn and soy bean, Japanese cane No. 2, and Japanese cane No. 1. In returns per ton of silage fed the silage ranked in the following order: Corn, \$6.15; Egyptian wheat, \$5.63; sorghum No. 1, \$5.38; corn and soy bean, \$5.27; sorghum



No. 2, \$4.81; Japanese cane No. 1, \$3.29; Japanese cane No. 2, \$1.17. The steers in this experiment were sold at \$12.50 per 100 pounds; \$74 per ton was allowed for cottonseed meal, \$15 per ton for molasses, and \$15 per head for marketing charges.

At the termination of the beef experiment, March 27, 1920, a beef-cattle day was held. Farmers and others were invited to inspect the fat steers and the beef herd and to study the results obtained, the final figures being placarded and posted conspicuously around the barns. About 500 persons were in attendance, and the meeting was very successful in bringing the farmers to a closer understanding of the work.

Grazing and feed records have been kept on 65 pigs of the fall of 1918 and 94 pigs of the spring of 1919, showing the gains made on various kinds of pasture. Some grain and tankage was fed in each case. The pasture consisting of corn and that consisting of barley, rape, and crimson clover gave better daily gains per head than good pasture of red and white clover or fair pasture of lespedeza and white clover.

Records of 723 pigs farrowed at the farm up to the end of the fiscal year show that it cost an average of \$3.14 to produce a pig weighing 27.85 pounds at 60 days of age.

The dairy herd, headed by the purebred Jersey bull Hillside Torono 101729, now contains 11 purebred Jersey and 6 grade Jersey cows. All the purebred cows are in the Register of Merit or on test. The profit per head over cost of feed for the herd of milking cows on their last full lactation period was \$132. The cost of raising heifer calves to the age of 1 year was \$72.75, and to the age of 2 years \$127.49.

To test the value of introducing Brahman blood among the beef cattle in the South, an experiment has been begun in which one lot of cows has been bred to a high-grade Brahman bull and a similar lot to a purebred Hereford bull. Cattle having Brahman blood seem to be better able to withstand such hardships as flies, mosquitoes, ticks, hot weather, etc., without being hindered in growth and gain, than some of the better-known beef breeds of cattle. Data will be kept on the rate and economy of gains made by the calves produced by these crosses from birth to marketing or maturity.

The experiment to determine the cost of raising mules has been continued. Seventeen colts at 1 year of age, weighing 611 pounds, cost \$42.85 per head; 14 at 2 years of age, weighing 907 pounds, cost \$130.57; while 12 at 2½ years of age, weighing 1,003 pounds, cost \$190.68.



# REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY.

UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF PLANT INDUSTRY,  
Washington, D. C., October 10, 1920.

SIR: I have the honor to submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1920.  
Respectfully,

WM. A. TAYLOR,  
*Chief of Bureau.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

## WORK AND ORGANIZATION OF THE BUREAU.

The Bureau of Plant Industry deals with the various plant problems of economic importance, especially those relating to crop production and utilization. These activities include the improvement of useful plants by selection and breeding, the investigation of destructive plant diseases and development of methods for their control, the introduction of new plants from foreign countries, the improvement in cultural methods for producing crops, and the development of improved methods of crop handling and utilization.

The bureau maintains field stations and conducts experimental work in all sections of the United States, including experimental work on irrigated lands on Government reclamation projects.

A seed and plant exchange service is conducted between experts of foreign countries and American experts. The bureau supervises the purchase and distribution of vegetable, flower, cotton, tobacco, lawn-grass, and drought-resistant seeds, and of bulbs.

The work of the bureau during the year has been carried on with the following organization:

Laboratory of Plant Pathology.....	Erwin F. Smith, Pathologist in Charge.
Pathological Collections.....	Flora W. Patterson, Mycologist in Charge.
Fruit-Disease Investigations.....	M. B. Waite, Pathologist in Charge.
Investigations in Forest Pathology.....	Haven Metcalf, Pathologist in Charge.
Citrus-Canker Eradication.....	Directed by K. F. Kellerman, Associate Chief of Bureau.
Blister-Rust Control .....	S. B. Detwiler, Forest Pathologist in Charge.
Cotton, Truck, and Forage Crop Disease Investigations...	W. A. Orton, Pathologist in Charge.
Crop Physiology and Breeding Investigations.....	W. T. Swingle, Physiologist in Charge.
Soil-Bacteriology and Plant-Nutrition Investigations...	Directed by K. F. Kellerman, Associate Chief of Bureau.
Soil-Fertility Investigations.....	Oswald Schreiner, Biochemist in Charge.
Crop Acclimatization and Adaptation Investigations...	O. F. Cook, Bionomist in Charge.
Fiber-Plant Investigations.....	L. H. Dewey, Botanist in Charge.



Drug, Poisonous, and Oil Plant Investigations.....	W. W. Stockberger, Physiologist in Charge.
Physiological and Fermentation Investigations.....	R. H. True, Physiologist in Charge.
Agricultural Technology.....	N. A. Cobb, Technologist in Charge.
Biophysical Investigations.....	G. N. Collins, Botanist in Charge.
Seed-Testing Laboratories; Enforcement of Seed-Importation Act.....	E. Brown, Botanist in Charge.
Cereal Investigations.....	C. R. Ball, Cerealist in Charge.
Corn Investigations.....	C. P. Hartley, Physiologist in Charge.
Tobacco Investigations.....	W. W. Garner, Physiologist in Charge.
Alkali and Drought Resistant Plant Investigations....	T. H. Kearney, Physiologist in Charge.
Sugar-Plant Investigations.....	C. O. Townsend, Pathologist in Charge.
Economic and Systematic Botany.....	Frederick V. Coville, Botanist in Charge.
Dry-Land Agriculture Investigations.....	E. C. Chilcott, Agriculturist in Charge.
Western Irrigation Agriculture.....	C. S. Scofield, Agriculturist in Charge.
Horticultural and Pomological Investigations.....	L. C. Corbett, Horticulturist and Pomologist in Charge.
Arlington Experimental Farm.....	E. C. Butterfield, Assistant Horticulturist in Charge.
Gardens and Grounds.....	E. M. Byrnes, Assistant in Charge.
Foreign Seed and Plant Introduction.....	David Fairchild, Agricultural Explorer in Charge.
Forage-Crop Investigations.....	C. V. Piper, Agrostologist in Charge.
Congressional Seed Distribution.....	R. A. Oakley, Agronomist in Charge.
Demonstrations on Reclamation Projects.....	A. C. Cooley, Agriculturist in Charge.

From September 1, 1919, to August 31, 1920, the changes in the personnel of the bureau were as follows: Resignations, 747; deaths, 8; transfers from bureau, 46; furloughs, 12; terminations of appointments, 616; dismissals, 3; making a total of 1,432 employees dropped from the rolls during that period. In the same period 1,165 appointments were made, leaving a net decrease of 267 in the total force of the bureau. On September 1, 1920, the numerical strength of the bureau was as follows: In Washington, 705; outside of Washington, 1,131; total, 1,836. The total number of employees in the bureau on the same date a year ago was 2,103.

The new publications of the bureau (Department Bulletins, Farmers' Bulletins, circulars and miscellaneous documents, with contributions to the Yearbook and to the Journal of Agricultural Research) number 74, of which 9 were joint contributions with educational institutions or with other bureaus or offices of the department. These 74 publications contain 2,144 pages, 115 full-page plates, and 774 text figures and were issued in first editions aggregating 1,258,760 copies. The number of publications issued during the preceding fiscal year was 130, containing 3,575 pages, 273 full-page plates and 671 text figures, the first editions aggregating 1,835,850 copies. The contributions of this bureau to the series of Farmers' Bulletins were reduced from 37 in 1918 and 29 in 1919 to 14 in the fiscal year covered by this report. Only two papers emanating from this bureau were printed in the Yearbook of the department for 1919. The number of contributions from this bureau to the Journal of Agricultural Research was 16. The very great reduction in the number of publications issued during the fiscal year was due to shortage of funds and the consequent withholding of many manuscripts for later issue. Revisions of 9 publications, containing 216 pages, were issued during the 12 months, in editions totaling 300,000 copies. Only 6 publica-

tions (not Farmers' Bulletins, which are reprinted automatically) were reprinted during the year, the total number of copies issued being 18,200.

For bulletins covering practically every phase of plant production in the United States, the Chief of the Division of Publications should be addressed.

#### PLANT-NUTRITION INVESTIGATIONS.

The chief feature of the work during the year has been the discovery that the seasonal length of day, that is, the duration of the daily light period, is a factor of first importance in determining plant development. As a result of these studies it has been possible to establish the relationship of the length of day to early and late maturing varieties of crop plants, the relative development of the vegetative and fruiting portions of the plant, the distribution of the growing and the fruiting periods through the year, the condition of "everblooming" or "everbearing," the adaptation of different varieties and species of crop plants to different latitudes, and the natural distribution of plant species. It has been demonstrated that the vegetative and the reproductive or flowering and fruiting periods can be suppressed or brought into expression almost at will through artificial control of the length of the daily illumination period and that for this purpose electric light may be successfully used as a supplement to sunlight during the short winter days.

The plant can not attain sexual reproduction, it has been shown, except when it is exposed to a favorable length of day. The requirements, however, differ widely with species and varieties. Furthermore, a length of day that is unfavorable to reproduction may be favorable to growth; under that condition the plant continues its vegetative development profusely and indefinitely without bearing fruit. A length of day may be found that is favorable both to sexual reproduction and vegetative growth, which tends to bring about the "everbearing" type of fruiting.

This new principle undoubtedly explains the erratic behavior which has been observed with many crops when they are shifted to different latitudes and may also clear up the conflicting results of variety tests and field tests conducted with the same crops but in different regions.

#### AGRONOMY, CROP BREEDING, AND HORTICULTURE.

##### COTTON.

*Increased production of Lone Star cotton.*—The popularity of the Lone Star, an early-maturing variety of the Texas big-boll type, originated by the Bureau of Plant Industry, is becoming greater each year. An important part of the Texas crop is Lone Star cotton, and the growth of the variety is being extended in Texas and other States, including southern California, as rapidly as the seed supplies can be increased. In spite of extremely unfavorable conditions of wet weather that injured much of the seed in the fall of 1919 and compelled extensive and repeated replanting in the spring of 1920, it was possible, by bringing a stock of pure Lone Star seed from southern Texas, to replant the fields of the Lone Star community



around Greenville, Hunt County, Tex., and thus maintain the central nucleus of pure-seed production of this variety. The idea of community growing and marketing of Lone Star cotton is extending rapidly in northern Texas, and several commercial seed firms are taking up the handling and ginning of Lone Star exclusively, which is also encouraging the production of this variety on a community basis. It is estimated that about 1,250,000 acres were planted to Lone Star in 1920.

*Acala cotton in Oklahoma.*—Acala, a big-boll type of cotton, acclimatized from Mexico by this bureau, is distinct from any of our native varieties and is somewhat earlier than Lone Star or Triumph, producing a similar abundance of lint, with a somewhat longer staple and often a higher yield. Though equal to any of the Texas varieties in stormproof quality, it is easy to pick, and the cotton comes out clean from the bolls because the fibers of each lock adhere firmly together. It is valued especially in Oklahoma on account of earliness and drought resistance and because the fiber sells more readily and brings a higher price than any other cotton adapted to general cultivation in that State. Buyers last year paid premiums of from \$15 to \$40 a bale for Acala cotton in the Oklahoma markets. Several seedsmen are adopting the Acala cotton as a specialty for Oklahoma and northern Texas, and from present indications this variety will be grown on a very large scale as soon as adequate supplies of pure seed can be produced.

*Meade cotton.*—Meade cotton is a new Upland long-staple variety developed by the Bureau of Plant Industry which is now replacing the Sea Island cotton in Georgia and South Carolina. The effort to maintain the seed supplies and extend the production of seed is being continued, in spite of the fact that many of the farmers have failed to keep their seed pure or have sold their seed at high prices for shipment to other States or export to foreign countries. But in view of the continued success of the variety it is believed that Meade cotton will be grown in the Sea Island districts in preference to any other. In one community nearly 600 acres of Meade cotton are planted together. About 2,000 acres are being inspected and rogued as the basis of a pure-seed supply, out of a total of about 5,000 acres in Georgia and South Carolina.

*Extension of Egyptian cotton.*—High prices for Egyptian cotton have led to greatly increased production in Arizona and California. Some of the 1919 crop sold for more than \$1 per pound. The Pima variety of Egyptian cotton is now being grown extensively in the Salt River, Gila, and Yuma Valleys of Arizona and in the Imperial and San Joaquin Valleys of California, with a total of nearly 250,000 acres planted in 1920 and a prospective crop value of from \$50,000,000 to \$100,000,000. Commercial demand for this class of fiber is increasing with the supply, and the competition of automobile-tire manufacturers for the Pima crop has become so keen that contracts have been made with farmers guaranteeing a minimum price of 60 cents a pound, or even 80 cents in some cases, as well as financial assistance in handling the crop during the growing and harvesting seasons. Confidence in the future of Egyptian cotton production is also manifested in the building of large automobile-tire factories at Los Angeles. The first industrial plant of this kind is being



erected at a cost of about \$20,000,000 by a company that has invested a similar amount of capital in the production of Pima cotton.

*Cotton possibilities of California.*—The results of the season of 1919 confirm the indications of previous years that the Pima variety of Egyptian cotton can be grown in the San Joaquin Valley even to greater advantage than in the more southern valleys. In spite of the earliest killing frost in many years, which occurred on October 27, 1919, yields of a bale per acre were secured from good fields. The behavior of the plant is more regular and normal than in the hotter valleys, with larger numbers of bolls matured earlier in the growing season on the lower fruiting branches. It is estimated that the San Joaquin Valley contains at least 1,000,000 acres of land from which normal crops of Pima cotton might be expected. Outside of the range of Pima cotton, good results may still be secured from some of the Upland varieties, and especially from Durango, Acala, and Lone Star, so that estimates of 2,000,000 or even 3,000,000 acres of cotton land in California are not considered excessive. Communities that limit themselves to a single superior variety, so that pure stocks of seed can be maintained, will have a further advantage in being able to supply seed for Texas or other States of the eastern cotton belt, especially in seasons when seed of planting quality is scarce, as in the spring of 1920.

*Two kinds of cotton branches.*—A beneficial control of the growth of cotton is made possible because the plant produces two distinct kinds of branches. The branches that develop from the lower joints of the main stalk have only vegetative functions and are entirely different from the fruiting branches, where the flowers and bolls are produced. That the two kinds of branches are distinct and that the vegetative branches need to be suppressed in the interest of early fruiting are fundamental facts in relation to many problems of breeding varieties of cotton and improving cultural methods. To make possible a full application of the results of scientific discovery in the handling of this important crop, the distinct structures and functions of the two kinds of branches need to be recognized by teachers, experiment-station workers, farm advisers, and writers of textbooks, as well as by practical farmers.

*Control of branching in cotton.*—For controlling growth and suppressing vegetative branches, improved methods of thinning and spacing have been devised and are now being applied. Instead of "chopping out" the very young cotton as soon as the seed leaves have opened, thinning is deferred until the plants are 5 or 6 inches high, or until the first fruiting branches begin to develop, with the small "forms," or "squares," that inclose the floral buds. And instead of the wide spacing formerly considered advisable, earlier and larger crops are being secured from plants 4 to 10 inches apart in the rows. The closer spacings are needed where there is more danger of rank growth and excess of vegetative branching. Spacing to the width of the hoe is becoming a popular standard, especially if the precaution of not thinning too early is observed. In open, scattering stands, with the plants averaging 3 or 4 inches apart in the rows, the labor of thinning may be saved, since no advantage may be secured.

*Open lanes between cotton rows.*—The system of controlling the growth and branching of the young plants was first worked out in

connection with Egyptian cotton and is in general use in the Salt River Valley. By withholding water, thinning rather late, and leaving the plants close together in the rows, it has been found possible to avoid the development of vegetative branches and to keep the lane open between the rows, so that all of the fruiting branches can mature bolls. Under the improved system each plant is formed of a single upright stalk, with its normal complement of horizontal fruiting branches, but there are no large vegetative branches to fill the spaces between the rows, as in fields that are not handled properly. When the lanes are closed by vegetative branches, fruiting is confined to the top of the plants after the upward growth begins to slacken in the fall, but the crop is late and may be ruined by frost.

*One-variety cotton communities.*—As a result of further study and experience with problems of cotton improvement, it becomes still more apparent that full utilization of superior varieties and scientific methods of handling the crop are to be expected only in communities that restrict themselves to a single variety of cotton. One-variety communities are necessary to maintain stocks of pure seed that are the basis of production and use of any variety of cotton on a scale large enough to give it a practical commercial and industrial status, and it is only in such communities that the habits and special behavior of a variety become sufficiently well known to permit the farmers to become really skillful in the handling of the crop, so that a product of the highest quality can be secured and placed to the best advantage on the market. In view of the progress that is being made through the organization of one-variety communities, it is believed that this plan opens the way to a general improvement of cotton production that is practically impossible in communities where different kinds of cotton are growing and any new variety "runs out" in a few years through mixture of seed at the public gins and crossing in the fields.

*Field inspection to determine the quality of cotton.*—Lack of discrimination of the quality of fiber in buying from the farmer is a feature of the commercial system that interferes with the improvement of production. Even the competent buyers who know how to judge the staple length from samples often fail to detect inferior mixed stocks, and farmers who produce superior uniform fiber may secure no advantage in price over the inferior fiber produced by careless neighbors. A way has been found to improve the system of buying by ascertaining the general quality and uniformity of the fiber through inspection of the cotton in the fields, in the same way that the fields are inspected to determine the quality and value of the seed for planting purposes. Purity and uniformity of the plants in the field are as important in relation to the fiber for textile uses as they are in relation to the seed, so that the same system of field inspection would serve both purposes. These facts are being brought to the attention of manufacturers to secure their interest in developing better methods of buying, which will encourage the planting of superior varieties of cotton.

*Factors of cotton production in China.*—The cotton-growing area of China, which was studied to some extent by our cotton specialists during the year, probably is larger than that of any other country,

but production is restricted in many ways. The total crop is estimated at 4,000,000 bales, though only about 2,000,000 bales pass into commerce or reach the industrial centers. In some of the northern districts the crop is of the Upland type, not unlike some of the small-boll short-staple varieties of our Southeastern States, but most of the Yangtze Valley cotton is of the native Chinese or Asiatic type—very small plants with narrow, deeply lobed leaves, very small bolls, and uneven fiber, much of it so short and kinky that the mills can use it only for coarse thread. Nevertheless, the Chinese cotton appears to be better adapted to the local conditions and farming systems of the coast districts than Upland varieties that are being planted experimentally. Improvement of the crop by selection is shown to be possible by the frequent occurrence of individual plants with fiber an inch or more in length and of good quality, and work of this kind is being undertaken at several agricultural stations in the different Provinces.

#### CORN.

*An Indian variety of corn that tolerates self-pollination.*—In commercial seed corn there is always a portion of the seed that has resulted from the silks receiving pollen from the same plant. In all of the varieties previously studied this self-pollinated seed is decidedly inferior, producing only weak, unproductive plants. Unless the detasseling of plants in alternate rows to insure cross-pollination becomes a general practice, the presence of self-pollinated seed will continue to result in reduced yields. If without the loss of other desirable qualities varieties could be developed that are tolerant to self-pollination, yields would be materially increased. A beginning in the direction of securing strains tolerating self-pollination has been made through the discovery among the varieties of maize grown by the American Indians of one from the Pawnee tribe that does not show the usual loss of vigor when self-pollinated. After being self-pollinated for four successive generations this strain shows no appreciable reduction in yield or vigor. The variety is early and very productive, and in addition to its value as a breeding stock it promises to be very desirable for ensilage, especially in semiarid regions.

*Chlorophyll disorders of corn.*—Further study of the minor abnormalities of corn has shown that the number of these detrimental variations is much greater than had been supposed. It now appears that the complete suppression of these abnormalities in the generation immediately following a cross of the unrelated strains is the explanation of the vigor and high performance that characterize first-generation hybrids.

*A dwarf variety of corn.*—In one of our corn hybrids a brachytic variation has appeared in which the mature plants are only about 2 feet in height, though otherwise full sized and normal. There is no reduction in leaf area, and the short-jointed plants are as productive as the tall plants of the same stock. This variation is similar in nature to that which has resulted in the production of bush varieties of beans, squashes, and other vegetables. One result of such dwarfing of corn is that the root system is greatly enlarged by increasing the number of root-bearing nodes below the surface of the ground.



This character, in connection with the shortened stature, eliminates all danger from lodging—a decided advantage in regions of high wind. An effort is being made to transfer this dwarf habit to some of the leading commercial varieties.

*Corn-teosinte hybrid.*—Teosinte, a Mexican grass and the only known wild relative of corn, is grown to some extent as a forage plant in the Southern States. It possesses many characteristics that would be of value in corn, especially in varieties grown for ensilage. Crosses between corn and teosinte have been made which show that within wide limits it is possible to secure any desired combinations of characters. Among the more promising segregates thus far secured from these hybrids is an early strain with the broad leaves and the strict, sturdy, upright habit of corn combined with the profuse branching of teosinte. The new type appears fixed, and an effort is being made to secure sufficient seed for field tests.

*Corn culture.*—Fair acre yields were obtained in northern Arkansas from early varieties of corn by planting much thicker than usual. By the use of such varieties it has been possible to have a succession suitable for hogging down from the middle of July until local varieties are ready in September. Improved methods of selecting and preparing seed corn have been determined and prepared for publication.

*Use of corn products.*—A new formula for the making of hulled corn, or lye hominy, has been devised. This method produces a better grade of hominy, and it is believed that it would be practicable to apply it on an extensive scale in the development of a trade in dried hulled corn similar to the existing trade in cracked hominy. Improved methods of popping and preparing pop corn have been devised and published.

*Corn breeding.*—An improvement in the ear-to-row breeding of selected strains that is being conducted in different sections of the United States has been put into effect during the past two years. The pollen parents in the breeding plats are restricted to ears known to be of high productiveness. This permits broader breeding and obviates detrimental effects that may result from the close breeding that occurs so frequently in ear-to-row plats. The benefits of this change are apparent already in some of the selections. Progress was made in the establishment of pure-line strains of United States Selection 201, and preliminary crosses between such strains promise valuable results in securing higher yields and better quality. Similar breeding methods have been started with three other varieties.

A method of breeding combining extensive self-fertilization and ear-to-row selection has made possible rapid progress in developing and fixing certain desired characters. In investigations conducted in Florida and South Carolina the application of the method to a variety of high yielding power but very deficient in resistance to weevils and to infections by molds has developed a strain in which the percentage of ears efficiently protected by long husks has been increased to 67 per cent from 15 per cent in the original variety.

From a much less productive variety, with 50 per cent of the ears fairly well protected with shucks at the beginning of the work, a strain is being isolated with 99 per cent of its ears in shucks tightly rolled and extending more than 3 inches beyond the ear tips and 88 per cent of the stalks producing two or more ears and giving other indications of high yielding ability.

Considerable progress has been made in segregating distinct types of corn from well-known commercial varieties. When isolated, the performance of these types is studied to determine those having high productiveness and other desirable characters.

#### WHEAT.

*Wheat classification.*—The field investigation necessary to the classification of the commercial wheat varieties grown in America is now practically completed. Keys separating more than 180 commercial varieties, and the histories, geographic distribution, descriptions, and synonyms of these varieties have been written. The synonyms bring the total number of varietal names nearly to 1,000. Several little-known varieties grown locally were brought to light by the varietal survey and have been studied in the field during this season. These will bring the total number of commercial varieties to approximately 200, and it is expected that the work on these varieties will be completed and the results prepared for publication during the coming winter.

Results from the wheat varietal survey have been tabulated. The data show the percentage of each variety grown in each county. Aside from the purpose of classification, the value of the varietal survey has been demonstrated in several other ways; for instance, when the investigation of the so-called take-all disease showed that certain varieties were very susceptible, it was possible to determine very promptly the districts in which those varieties are grown commercially and the approximate importance they had in those districts. With this information at hand, prompt action could have been taken to discontinue the growing of these varieties everywhere had this disease continued to spread.

*Wheat production.*—Cooperative studies of the effect of time of seeding wheat in Georgia have shown the bad effect of late sowing. Two varieties sown on October 15 yielded 44.4 and 43.7 bushels, while the same varieties sown on November 15 yielded 12.5 and 17.9 bushels per acre, respectively.

*Extension of wheat varieties.*—In addition to the Early Baart and Dicklow, two white wheats found well adapted to dry-land and irrigation conditions, respectively, in parts of the far West, two Australian varieties are proving excellently adapted to dry-land conditions in the Pacific Coast States. The principal white wheats of the Pacific coast, including Early Baart, are of Australian origin. In the experiments during the last three or four years the Hard Federation and White Federation, two varieties bred in Australia, have proved outstandingly high yielders. Milling and baking experiments have shown the quality of the grain also to be high. The Hard Federation has proved the better in the Pacific Northwest, while the White Federation has slightly exceeded it in California. The cooperation of the large milling companies of the Pacific coast has been enlisted in giving these varieties a thorough trial both in fields and mills. As a result, it is planned to begin their commercial distribution at the close of this season.

In 1919 the commercial production of Marquis wheat had increased to nearly 14,000,000 acres, or about 60 per cent of the total spring-wheat area of the United States.

A selection from the white-kerneled variety, Dawson Golden Chaff, and a selection of the red-kerneled variety, Prosperity, have been distributed rather widely in New York State. A somewhat different red-kerneled selection which appears superior to either of those mentioned has reached the stage where it has been decided to distribute it. Such selections are increased through cooperation with careful farmers who give special attention to keeping the variety pure and to producing seed of good quality.

Durum wheats have continued to outyield the common wheats, including Marquis, in the northern Great Plains area, and the proportionate acreage of durum wheats has increased. Their superior productiveness is due partly to drought resistance and partly to rust resistance. In 1919 they were more severely rusted than ever before. Of the two leading commercial varieties, Kubanka has proved to be somewhat more resistant to rust than Arnautka, although the contrary had been supposed to be true. This caused a large increase in the acreage of Kubanka in 1920.

*Wheat breeding.*—Hybridization experiments started at Moro, Oreg., in 1916 for the purpose of originating an awnless hard red winter wheat of the Turkey type have resulted in valuable material. About 400 awnless selections of Ghirka Winter  $\times$  Turkey hybrids are being grown in Oregon, Colorado, Kansas, and Montana in order to determine the best strain for yield, winter hardiness, and quality.

An extensive series of hybrids made in 1917 and 1918 between Marquis, the principal hard red spring wheat, and Kanred, the rust-resistant and productive hard red winter wheat, is being grown, with the object of producing a spring wheat with the milling qualities of Marquis and the rust resistance of Kanred and to originate a beardless winter wheat superior to Kanred in milling value.

Crosses were made in 1919 between Kota, the rust-resistant hard red spring wheat, and several leading commercial varieties, in an endeavor to increase rust resistance in the latter.

Kota, which was found in 1918 to be especially resistant to stem rust, was grown at 13 stations in the North-Central States in comparison with commercial varieties of both common and durum wheat under conditions favorable for rust development. Its rust resistance proved equal to that of the most rust-resistant durum varieties. As a result, it is being increased for commercial distribution.

Certain durum varieties, including Acme, Mindum, Monad, and D-5, not widely grown commercially, proved to be markedly rust resistant. The cultivation of Acme is being extended rapidly in South Dakota, and that of Mindum, in Minnesota. D-5 is a red-kerneled durum wheat which, although highly rust resistant, is of comparatively low milling value. For this reason its market value is low, and growers have been advised to substitute other rust-resistant varieties. The Monad variety has been increased for that purpose in North Dakota.

Research in the genetics of wheat has been continued, with promising results. In cooperative investigations in New York, much light has been thrown on the origin of the different groups into which wheat is separated. Among the progeny resulting from combining representatives of different groups has been a plant practically iden-



tical with the so-called "wild wheat" of Palestine, which, however, is not a true wheat but a primitive type of emmer. Breeding for adapted varieties suitable for use in different sections of the country has continued as usual. Among recent results are selections isolated in cooperative experiments in Georgia and now advanced to the point of being distributed for commercial growing in that State. Similar work previously reported in New York is being continued there. New hybrids are made annually to obtain certain desired results, and selection of their progeny continues.

#### OATS.

*Oat breeding.*—Oat-breeding experiments have been continued in cooperation with the New York, Iowa, and Idaho Agricultural Experiment Stations, respectively; also with winter oats at the Arlington Experimental Farm. The chief problem is the production of higher yielding strains than the varieties now grown commercially. This is accomplished through the intensive study of numerous pure-line selections from commercial varieties and through hybrids made to combine the good qualities of different parents. This investigation already has resulted in the production of valuable pure lines from the Welcome and other varieties in New York, from the Kherson and Sixty-Day varieties in Iowa, and from the Silvermine variety in Idaho. Already the acreage of these well-bred selections runs into the thousands in some States and into millions of acres in others. There is an urgent need for the extension of this line of breeding; also for a vigorous attack on the problem of breeding oats for resistance to both stem rust and crown rust.

In New York the value of selections from Welcome and other commercial varieties has been demonstrated, and the best of these have been distributed through cooperators. The demand for seed of these improved strains has been much greater than the supply, and every effort was made in 1920 to increase the supply and make it available. In Iowa and adjoining States, Iowa No. 103 (Albion), an early white selection from the Kherson, continued to be the most popular oat. The Iowar, another white selection from Kherson, which is slightly later and taller than Iowa No. 103 and averages 3 bushels more to the acre since it was placed in the field trials, was distributed to farmers for the first time in 1919. Present indications are that it will become as popular as the earlier selection (No. 103). At Aberdeen, Idaho, lack of land has made it impossible to grow new selections in sufficient quantity for distribution, but this lack has now been remedied, and a pure-line selection of Silvermine will be available in limited quantities next spring.

A very complete collection of American oat varieties was obtained from dealers and experiment stations in the fall of 1919 and the spring of 1920, with the intention of reviving and completing the classification of varieties, which had been held in abeyance during the war period. The study of fall-sown varieties could not be completed, because of the almost complete winterkilling of all oats sown on the Arlington Farm, but good progress is being made on the classification of spring varieties in the extensive nurseries at Ames, Iowa, and Aberdeen, Idaho.

## BARLEY.

*Barley breeding.*—The breeding of awnless barleys has received a new impetus from the discovery that the shattering of previously developed awnless strains is due to a deposit in the rachis of the surplus mineral matter normally deposited in the awns. It has been found that certain awned selections normally deposit much less of such mineral matter than do others. By using these as parents in crosses to produce awnless forms, there are good prospects of developing a nonshattering awnless barley. Such a form is greatly desired by growers and feeders, to whom the awns are very troublesome.

In the mean time breeding is being continued with several smooth-awned selections in which the awns have none of the sharp, rough teeth and therefore are not particularly objectionable. Several strains having smooth awns have been developed, and their value as producers under different sets of conditions is being determined.

The results of two inheritance studies in barley are in press. Research on the occurrence of the fixed intermediate, *Hordeum intermedium*, in crosses indicates that the agricultural varieties of this species have resulted from natural hybrids. That such a number of accidental hybrids have found their way into field culture adds further weight to the value of hybridization in the production of new varieties. Studies of the inheritance of density in the spike add information as to the use of this character in the separation and identification of varieties.

*Physiological studies of barley kernel development.*—Three phases of the physiological study of the development of the barley kernel have been completed and the results submitted for publication. These are: (1) Development of the kernel under normal conditions, (2) comparative development in normal awned spikes and in spikes from which the awns are clipped as they emerge, and (3) development under different applications of irrigation water.

Two other phases of this research, covering studies on the course of water and of ash in the kernels, are being completed during the present season.

## RICE INTRODUCTION AND EXTENSION.

A collection of Porto Rican and Dominican rice varieties which has been made in the last two years is being studied under tropical conditions at Mayaguez, P. R., and Jaina, Dominican Republic. They also are being studied at Crowley, La., to determine whether they may be used in rice production without irrigation in the South Atlantic States.

A few of the rice varieties that have been developed at the Crowley rice station have been distributed. The most important of these are Acadia and Fortuna. They produced high yields in 1919 under field conditions, an average yield of 5,155 pounds of rough rice having been obtained from Acadia on 48 acres and an average of 2,775 pounds of rough rice from Fortuna on 35 acres of very old land. In California several early-maturing selections of good quality and high productiveness have been developed at the Biggs rice field station. Two of these—the Butte and the Colusa—were grown last season in California on 55,000 acres, out of a total of 142,000 acres

of rice in the State, and produced 1,110,000 and 1,665,000 bushels, respectively, with an estimated farm value of approximately \$7,000,000.

#### FLAX.

*Flax breeding.*—Studies of an extensive series of hybrids have been conducted in cooperation with the North Dakota and Wisconsin Experiment Stations. Some of these hybrids were made to determine the inheritance of plant and seed characters and others to obtain wilt-resistant strains.

*Flax culture.*—Experiments in growing flax on breaking in North Dakota during a three-year period have been completed and the results published. The varieties proved best adapted are those of the Russian seed-flax type now widely grown in the flax belt. Home-grown or domestic seed is better than that imported. Early seeding, between May 1 and June 10, is much more profitable than later sowing, although where a catch crop must be sown, flax sometimes does well when sown still later.

#### EXPERIMENTS IN BLUEBERRY CULTURE.

About 15,000 hybrid blueberry plants produced in the greenhouses at Washington have been grown to fruiting age in the cooperative blueberry plantation at Whitesbog, 4 miles east of Browns Mills, in the pine barrens of New Jersey. From these plants four have been selected and placed in the hands of nurserymen for propagation and distribution. The first of the selected hybrids will be on sale in the spring of 1921. The largest berries on these selected hybrids are three-fourths of an inch in diameter. They are of delicious flavor and have good shipping qualities. Additional selected hybrids which have produced berries up to four-fifths of an inch in diameter are now in process of propagation. The crops produced on the cooperative plantation at Whitesbog indicate the great promise of blueberry culture as an agricultural industry.

#### FRUIT IMPROVEMENT THROUGH BUD SELECTION.

This activity has continued during the past year as in previous years and has been confined primarily to the further accumulation of individual-tree performance records and similar records on progeny trees which have been propagated from particular parent trees of known production performance. This line of work in California has been carried on for a considerable period of years on the Washington Navel, Valencia, and Ruby oranges, on the Lisbon, Eureka, and Villafranca lemons, on the Marsh grapefruit, and on the Dancy tangerine.

Incident to the citrus bud-selection work, certain important production studies have been made. These relate to pruning and to methods of applying organic manures. Pruning investigations carried on from 1914 to 1919, inclusive, have been based on three different degrees of pruning; namely, heavy, medium, and light. These studies have been carried on with the Washington Navel orange, the Marsh grapefruit, and the Eureka lemon. The result of the pruning work, as measured by the product, has been consistently in proportion to the extent of the pruning. The very heavily pruned trees have



yielded the least, while the lightly pruned trees have yielded the largest crops of the best fruit. The practical results of these experiments have been to check, rather decidedly, the tendency among citrus growers in California toward heavy pruning.

The furrow system of applying organic fertilizers in citrus orchards was introduced as a result of a study of similar methods at Bahia, Brazil. This method consists substantially of placing stable manure, alfalfa, bean straw, or such other organic material as may be used for improving soil conditions in rather deep furrows that are made a short distance from the trees and then covering it with soil. In one plat of citrus trees where this investigation was carried on, the trees in the section where stable manure was applied in furrows at the rate of 10 cubic feet per tree, compared with others where a similar quantity was applied broadcast and plowed under in the ordinary way, showed an improved physical condition which was very striking and apparent to every observer, and these trees produced in the year following the application more than four times as much fruit as the trees to which the application was made in the usual way. The results of the tests made along this line have been so striking and so convincing to the growers that the furrow method of using manure or other organic fertilizing material has now become practically universal in southern California. The available evidence demonstrates that 5 cubic feet of manure in the furrow is as efficient as twice that quantity when broadcasted and plowed under in the usual way. During the year 1919 the saving of organic manures in California citrus orchards was estimated by the fertilizer distributors in that State to have amounted to more than \$1,000,000.

There have been many commercial applications of the results of this work. Growers in California are keeping tree-performance records on more than 50,000 acres of citrus fruit. These records are utilized by the growers for the purpose of locating superior trees as sources of bud wood for propagation, for finding undesirable trees of inferior strains for top-working, for systematically giving the trees in the orchards individual care in regard to pruning, fumigating, spraying, or other necessary attention and treatment, and for determining the results of cultural practices, such as fertilization, irrigating, and other factors of orchard management. These records are voluntarily turned over to the bureau representatives for their use.

#### NUT-PRODUCTION INVESTIGATIONS.

Most of the work now in progress on pecans represents long-time investigations. The activities include a continued study of varieties and their relative merit and adaptability to different conditions and certain important cultural studies, such as cover crops and other means of soil improvement and maintenance, the use of fertilizers, tillage, etc. Extended observations have also been made on the premature shedding of the nuts, with a view to determining, if possible, the cause and prevention of this phenomenon. One experimental plat in the vicinity of Putney, Ga., has been equipped for irrigating, the object being to determine the influence of increased water supply during periods of drought. However, since the installation of this irrigating system, there has been such an abundance of rainfall as to make the application of water unnecessary.

In view of the fact that very many of the pecan orchards that have been planted in southern Georgia and elsewhere are on soil that is very different from that which occurs where most of the native stands of pecans are to be found, there is a growing conviction that there are some important soil factors that are very definitely involved in the success of these planted orchards. It is with a view to determining some of these factors that extensive fertilizer, cover-crop, and other cultural activities are being prosecuted.

The bearing records of a number of pecan orchards are being secured annually by this bureau. These results show that some orchards regarded by the owners as profitable contain a surprisingly high percentage of trees that are unproductive. Such trees are maintained at the expense of the higher yielding trees. The profits on an acreage basis, therefore, are very much reduced as compared with what they would be if all the trees yielded as well as the better producing trees. Some attention has been given also to the matter of grading and sizing pecans for market. Because of opposing conditions that exist in certain pecan-growing regions, it is difficult to secure unanimity of opinion among the growers with reference to what ought to constitute grade standards. This matter is being considered from the standpoint of the industry, since it is felt that only one set of grade standards should be recognized and promulgated.

In the case of almonds in California there appears to be a rather acute varietal problem in that a great number of varieties are being grown. This makes considerable trouble in marketing the product. The study of varieties that has been inaugurated is being carried forward with a view to determining from actual records and observations what varieties are the most profitable; also the adaptability of different varieties to different conditions. As a result of such studies it is hoped that all but a certain few of the best sorts can be eventually eliminated.

The studies of Persian walnuts and filberts have been in the nature of surveys for the purpose of getting in touch with the production problems, to compile the data relative to cultural methods, and to formulate some adequate conception of the methods and practices that are yielding the best results under different conditions.

Incidental attention has been given to the study of hickories, black walnuts, and other nuts which possess more or less value for growing somewhat widely throughout the North.

#### FRUIT JUICES.

In the clarification of fruit juices it is felt that some very material and important progress has been made. During the season of 1919 samples of juice were obtained from 62 varieties of grapes and 167 varieties of apples. These were pasteurized by routine methods in glass containers as promptly as possible after being pressed out and were stored in a cool room for study during the winter and spring months. As had been anticipated from the results of earlier work, all the samples of apple juice remained persistently turbid at the end of four to six months storage, and none of these could be materially improved by ordinary filtration, as much of the suspended colloidal matter passed through the filter. Filtration was also in all cases exceedingly slow. In the grape-juice samples, some 20 of the 62 varietal samples underwent complete or practically complete sedimenta-

tion in the storage containers and could be withdrawn in clear condition. The statements in regard to the apple juices just made apply equally to the remaining 42 samples of grape juices. It was therefore clear that satisfactory and generally applicable methods of clarifying these juices must be worked out before any effective attack upon the problem of blending to produce desirable beverage juices could be made.

Many different methods of treatment have been tried, the most of which are objectionable for one reason or another. However, it has been found that by the use of infusorial earth it was possible to satisfactorily clarify all grape juices and unfermented apple juices made during the past season, the resulting products remaining perfectly transparent after pasteurization and retaining the characteristic flavor of the untreated juices.

The results obtained with these juices, which had previously been stored for four to eight months, suggested that it might be possible to clarify the juices immediately after pressing and prior to pasteurization. If this should turn out to be feasible, it would eliminate the necessity for pasteurizing in a storage container, storing for some months, filtering, and repacking in the final containers, thus reducing the labor and cost of production and making the product immediately available for use. It was further believed that the "cooked taste" commonly observed in pasteurized fruit juices is due not so much to loss of flavoring constituents during pasteurization as to caramelization and other changes produced in the suspended colloidal material by heat, and it was hoped that the removal of this material prior to heating might prevent the development of the "cooked taste," while the elimination of one pasteurization should aid in the preservation of more of the characteristic fruit flavor than is otherwise possible.

With these considerations in mind, work was begun with apple juices as soon as material could be obtained. None of the samples of fruit thus far available has been of such character as to give a juice of first quality, as the juices of early-maturing varieties are of indifferent or poor quality, but it can be said that there is satisfactory preservation of their characteristic flavor after subjection to treatment. Samples of these juices have been pressed, treated, filtered, placed in final containers, and pasteurized within two hours after pressing and retain satisfactory color and flavor, comparable with that of the untreated juice. Also, as anticipated, a "cooked taste" does not develop in juices pasteurized subsequent to the removal of the colloidal matter, and cloudiness and sedimentation do not appear when such juices are repasteurized at a temperature higher than that of the first treatment.

The experiments this season have comprised some 15 varieties of apples, including only the earliest maturing varieties, and the material was in most cases immature. The method will be thoroughly tested with later maturing fruits, but the results so far obtained give encouragement to believe that it will be possible to clarify any and all apple juices with a very great reduction in time and labor and with entire elimination of the long storage period prior to use, at the same time preserving more of the characteristic flavor and securing a more satisfactory appearance than has been possible hitherto.



## FACTORS AFFECTING THE STORAGE LIFE OF FRUITS.

Fruit-storage activities have been directed toward a study of the behavior and ripening of Bartlett pears when picked at different times and stored at different temperatures, a continuation of the study of the interior browning of Yellow Newtown apples grown in the Watsonville district in California, frost-injury work based on a determination of the freezing points of different fruits, the effect of holding the material at different temperatures for different lengths of time, Satsuma orange curing, grapefruit storage experiments, and various activities of relatively minor importance.

The work with Bartlett pears was carried on principally in California with fruit produced in the Yakima Valley, Wash., in the Rogue River Valley in Oregon, and in California. In general, the results of the work in 1919 have shown that hard-ripe Bartlett pears can be stored for two months or more at a temperature ranging from 28° to 30° F. and that the fruit will be in good condition at the end of this period. From analyses of the fruit it has been shown that the sugar content and the dry matter increased the longer the pears were allowed to remain on the tree.

Further, it was found that there was considerable difference in the acid content of fruit from the different regions, the more northerly grown fruit apparently possessing more acid than that grown in California. Whether this is a constant difference or whether it is seasonal can be determined only by further work. The investigations are being continued the current season.

The studies of apple browning in the Watsonville district have been in progress for a considerable number of years. However, no definite cause of the trouble can yet be assigned. Work is being continued along several different leads which have appeared as the work has progressed. Certain beliefs which have been held from time to time have been disproved; for instance, that there is some correlation between the acidity of the fruit and the browning.

Experiments in the curing of Satsuma oranges were carried on last season in Baldwin County, Ala., where the Satsuma orange industry is on a better commercial basis than it is in some other parts of the Gulf coast region. This type of orange reaches its highest quality for consumption some weeks before it attains a yellow color. If allowed to remain on the tree until it is colored, it has a tendency to become flat and tasteless. It has been shown through laboratory tests and by experiments carried out on a fairly large scale in Alabama that by exposing the fruit to an atmosphere of gases formed by the imperfect combustion of kerosene and certain other petroleum products, it will develop a desirable color in four or five days. The marketing of fruit so cured resulted in sales at a somewhat higher price than the uncured fruit of the same grade.

The storage work with grapefruit showed that fruits differently handled behaved very differently in storage. As to the details, it has been found that the acid content of grapefruit decreases during storage, while the sugar content apparently remains practically the same at all storage temperatures used. Fruit was stored at 32°, 36°, 40°, and at common storage (about 60° F.). The bitter principle of

grapefruit apparently decreases during storage, as the fruit seems considerably sweeter after a period in storage.

#### SWEET-POTATO INVESTIGATIONS.

The importance of the sweet potato has increased very materially during the past few years. The curing and storage work has been conducted principally at Arlington Farm, Va., and at the Peedee substation of the South Carolina Agricultural Experiment Station at Florence, S. C., the latter work being cooperative. A general summary of the curing and storage work is expressed in the statement that where the potatoes are carefully handled during the harvest and cured in a storage house of the design recommended by this department for a period of ten days to two weeks at a temperature of about 90° with plenty of ventilation, followed by storage in an approved storage house at a temperature of 52° to 56° F. with occasional ventilation, practically all varieties can be kept through the winter with a loss from decay on an average of not to exceed 1 per cent.

With the development of a Satsuma orange industry in certain areas of the Gulf coast region and the probability of the construction of houses for use in fruit curing, some attention has also been given to the possibilities of making a dual-purpose house, not only for the Satsuma orange work but for sweet-potato storage. It is believed that there are no difficulties existing with respect to utilizing the same structure for the successful handling of both of these crops. It has also been shown that the type of tobacco-curing house used in some sections can be adapted readily to the needs of sweet-potato curing and storage.

#### VEGETABLE FORCING.

The studies of the forcing of vegetables have been confined primarily to cucumbers, tomatoes, lettuce, and cauliflower. Planting distances and other cultural problems have been investigated; also the results of seed selection, particularly in the latter case with cauliflowers. It has been shown that plants from carefully selected seeds yielded about 90 per cent of marketable heads, as compared with about 50 per cent of marketable heads from plants grown from unselected seeds.

#### IRISH POTATO PRODUCTION INVESTIGATIONS.

The Irish potato investigations were considerably extended the past year, the extension being mainly along two lines, namely, seed-potato development and the testing of northern-grown certified seed or inspected Triumph seed in the South. In carrying forward the seed-potato development work, cooperative arrangements have been made by this bureau with a number of experiment stations, including those in Oregon, Minnesota, Wisconsin, Louisiana, Texas, Oklahoma, and Arkansas, the cooperative work with the four stations last mentioned involving particularly the testing of northern-grown seed in southern potato-growing regions.

In testing the high-grade northern-grown seed potatoes at southern points the fact was very markedly brought out that the different lots of inspected or certified seed when grown under similar condi-

tions in the South may produce very strikingly different results in yields and that the better strains in some instances show a yield of 200 bushels or more per acre in localities where the average production from the seed commonly used is not more than 50 or 60 bushels. Moreover, there is wide variation in the yields of the different lots of the same variety.

The work relating to the durability and vitality of seed stock when held in cold storage for different lengths of time is naturally progressive. The work thus far indicates the possibility of using potatoes for seed purposes which have been held in cold storage for at least two years. These investigations have a bearing on the possibility of safeguarding valuable seed supplies. If it proves practicable, for instance, to hold over in cold storage for at least one season seed supplies grown in years when the crop is very large and the prices are low, in contrast with a frequent practice of unduly reducing the seed supply in seasons of light crops and correspondingly high prices, it will contribute materially to the economics of the industry.

#### FACTORS AFFECTING THE STORAGE LIFE OF VEGETABLES.

Work on the storage life of vegetables has been carried on with several different crops, including studies of the ripening and handling of tomatoes in Florida. These ripening and handling investigations of tomatoes yielded results which are of very definite importance to the industry. As ordinarily handled in a commercial way, the tomatoes are shipped from Florida to the northern markets during the winter and ripen very irregularly, frequently possessing undesirable flavors, and not infrequently there is considerable loss from decay or other forms of deterioration.

It was found with regard to the fruit when picked that the individual specimens of the same age from the blossom ripened uniformly after picking, thus indicating that the age of the individual fruits from the blossoming time should be the guide in picking rather than the size of the fruit.

As ordinarily shipped, the individual fruits are wrapped when packed. In this work it was determined that the undesirable flavor of the fruit picked before it was fully ripe and ripened artificially, as compared with vine-ripened fruit, is due to ripening under insufficient ventilation. It was also determined that under proper ventilation it was possible to ripen fruit picked before it was fully mature, so as to compare favorably with vine-ripened fruit. This development appears to suggest that it would be better to ship the fruit unwrapped than wrapped, although no actual shipping test could be made in connection with this work with a view to demonstrating this point. It was found, further, in the course of these investigations, that during the ripening period of tomatoes there is an increase in the moisture, acid, and sugar and a decrease in the solids, total nitrogen, starch, pentosans, crude fiber, and ash.

#### FLORICULTURAL INVESTIGATIONS.

This activity has been carried on principally at Arlington Farm, Va., and at Bell Station, in Maryland. At Arlington Farm the rose test garden has been continued as in previous years, as have also



the collections of hardy chrysanthemums and of peonies and Japanese irises.

The rose garden is maintained in cooperation with the American Rose Society, and a report of the results has been published in the Rose Annual of that society for both the years 1918 and 1919. Detailed records are made of the blossoming of the different plants and varieties and their behavior in other respects. The work with chrysanthemums consists fundamentally of a study of varieties and their adaptability to different purposes; also the development of earlier flowering varieties. The collection has been reduced to 68 varieties, which represent the earliest flowering individuals selected from purchased collections and from about 10,000 seedlings grown in 1917 and 1918. Most varieties of this group blossom too late to be desirable. It is for this reason that special attention is being given to the development of earlier blossoming sorts.

#### BULB-CULTURE INVESTIGATIONS.

*Dutch bulbs.*—The results with Dutch bulbs on Puget Sound point to most gratifying conclusions. The character of the crop just harvested has given encouragement to a number of people interested in the commercial production of these stocks and shows even more conclusively than any previous one that both narcissi and tulips of first quality can be produced on the loamy as well as the sandy soils of the region. The indications, however, are that the production is more economical on the sandy land than on the heavier loams.

While the investigations in this subject are experimental, it is found that the actual production of stocks at present market prices is an item that attracts attention. The total turn-off of surplus stocks from the experimental plats this season was close to 700,000 bulbs, which had a market value of \$10,000 to \$12,000.

With reference to hyacinths, it may be predicted that as good success may be had as with tulips and narcissi. The second season's growth of the 1917 propagation has been studied and indicates that the major portion of a propagation of hyacinths can be marketed the third year and the remainder of it the fourth, as a combination of variable quantities of first and miniature sizes.

In the culture of Dutch bulbs the most spectacular feature of the past year's work is the result obtained with spent bedding tulips. These when heeled in to mature have given in the East and at our western station at Bellingham as good results as they did the year imported and can be used again for bedding after being grown in nursery form one year. It is urged that the wasteful practice of discarding such material be discontinued.

Progress is being made with the culture of lilies, grape hyacinths, the bulbous iris, Camassia, Brodiaea, and Scilla; and various other items are being accumulated as rapidly as possible.

*Easter lilies.*—It has been demonstrated that it is perfectly feasible to produce these stocks out of doors in the latitude of Washington. The seedlings grown at Arlington Farm, Va., are free from disease, vigorous, and yield when forced better than imported material. Four to five inch seedling bulbs give an average of five flowers when forced. It is found perfectly practicable to grow the best stem bulblets to forcing size in one and two years, so that when

seedling stocks are once worked up vegetatively produced propagating stock takes care of itself in the regular course of production.

This lily is found to be most adaptable. Plants in vegetative condition in the field when winter sets in can be potted up even when showing buds and flowered without wilting. The plants will stand 2 or 3 degrees of frost even in bud, but in case of plants which have not begun to form a stem a temperature of 20° F. will do little, if any, injury under the climatic conditions prevailing at Washington.

For best results the bulbs should be planted late (early November). If this is done, no top growth occurs until spring in this latitude. It is for this reason that the plant is better adapted to this climate than to that of the Gulf coast, where it finds growing conditions in winter interspersed with an occasional drop in temperature to 10 degrees or more below freezing. Under such a condition the plants are not hardy.

The practicability of the home production of the Easter lily has been demonstrated. The production has been put upon a seedling basis, with handling methods comparable to those now in vogue with many herbaceous biennials and perennials.

*Palestine irises.*—Work on these stocks is also giving gratifying results. Very poor results have usually been had with these most handsome of all the genus *Iris*, in this country, but the location at Chico, Calif., seems to be such as to assure success in growing them. Doubtless a situation about 1,500 to 2,000 feet higher in the mountains in the same region would be better adapted. However, with a mulch to prevent the excessive summer baking of the soil good stocks can be produced.

Many of these varieties are coming to be recognized as good florists' items, and our investigations show that they can be brought into flower in January and possibly by Christmas.

#### DATE CULTURE.

The date industry established by the Bureau of Plant Industry in the hot irrigated valleys of Arizona and California shows promise of becoming one of the great fruit industries of the Southwest. Certain varieties of dates succeed very well in the United States and yield a product of superlative excellence, much superior to any now imported. It is believed that the culture of dessert dates of high quality offers a very promising field for future commercial development wherever the soil and climatic conditions permit.

*A new method of ripening dates.*—A discovery of the greatest importance, the Trabut-Drummond bag method of ripening dates, was made in the autumn of 1919 in connection with the investigations of the establishment of date culture on a commercial scale in the United States. By this method heavy paper bags are put on the bunches of fruit when the latter have reached full size but before the dates have begun to soften in the final ripening process. These bags protect the ripening fruit against dust and insects, and, what is a further advantage, against dews and rains, while at the same time they equalize the humidity and temperature; that is, the humidity is kept up over the hot mid-afternoon period, and the temperature is kept up during the cold part of the night preceding sunrise.

As a result of the use of this method the percentage of fancy dates of the Deglet Noor variety as grown in the Coachella Valley of California has been more than doubled and the number of pickings reduced from 12 to 2. In addition, the final curing of the fruit is greatly simplified, being accomplished by proper handling in a moist, warm room for only a few hours. As a result of this method, it is believed that date culture will be extended from the Coachella Valley, where it is now centered, to the Imperial, Yuma, and Palo Verde Valleys in California, the Salt and Gila River Valleys in Arizona, and to some parts of the Rio Grande Valley in Texas.

*Origin of new varieties of dates by breeding.*—During the past 10 years steady progress has been made in the breeding of new varieties of dates by using the pollen of pedigreed male trees to fertilize choice varieties. Probably 50,000 seedling dates have fruited in California during the past 10 years, and a few of these are choice varieties worthy of propagation.

There can be no doubt at the present time that date varieties as good as any that have been imported from the date gardens of the Old World are being originated in the southwestern United States. Even the famous Deglet Noor, perhaps the choicest sort now grown commercially, has been reproduced in seedlings, having, it is true, certain slight differences from the mother variety, some of them advantageous.

*Importation of date offshoots from Egypt.*—In the spring of 1920 an expert of the Bureau of Plant Industry went to Egypt and was able to secure, with the cooperation of the Egyptian Government, a large number of offshoots of two Egyptian varieties that have proved to be well adapted to cultivation in the United States. Some 2,000 offshoots are of the Saily variety, which is adapted for culture in the hottest valleys of the Southwest, such as the Coachella and Imperial Valleys of California, and some of the hotter irrigated districts of Arizona. This variety is noteworthy in that the fruit improves on storage and is distinctly better at Easter than when picked from the trees in November. The standard Deglet Noor variety, on the contrary, is best when first picked and unless stored very carefully deteriorates after a few months. It is confidently believed that the Saily and Deglet Noor can be grown together advantageously in the principal date regions of the Southwest.

The Saily also has a very great advantage in that the mother tree produces a very large number of offshoots; 25 or even more may be produced during the offshoot-bearing period of the mother tree, whereas an average of only half this number of offshoots will be produced by a Deglet Noor palm in the same period of time. Furthermore, the Saily offshoots are very easy to root.

It appears certain that the Saily, with its ability to produce numerous offshoots that can easily be rooted, will drive out the inferior varieties which might otherwise be propagated. This is a matter of very great importance, since the planting of inferior varieties of the date palm is more dangerous than with any other fruit tree, because date palms can not be top-worked by budding or grafting to better varieties. The inferior trees must be dug up and destroyed if they are to be replaced by better sorts. Because of the expense of this it is probable that in many instances an inferior sort once planted would be allowed to remain, even though it yields little or no profit.



In addition to the 2,000 offshoots of the Saidy, several hundred offshoots of the Hayany variety were also secured. This is an early-ripening date which has proved well adapted for growing in Arizona. It is one of the handsomest of the palms, and a few trees in a dooryard lend a strikingly ornamental effect to the landscape, while at the same time yielding a supply of fresh dates for home use.

#### SMYRNA FIG GROWING IN THE UNITED STATES.

The Smyrna fig industry in California has undergone such a rapid expansion that it promises to become one of the major fruit crops of that region. The absolute dependence of this valuable crop on the supply of the fig insect (*Blastophaga*) for fertilizing the Smyrna figs and the growing scarcity of insect-bearing figs at the critical time of fruit setting have emphasized the importance of such caprifig plantings as the department has maintained at Loomis, Calif., and the need for similar small collections in protected localities, ripening their crops at different times. The supply of caprifigs made available from the Loomis garden has saved fig growers many thousands of dollars during the past season, not only by preventing private distributors from setting an exorbitant price on their surplus supply but in the actual saving of whole crops dependent upon securing caprifigs at the proper time.

Some progress has been made in the investigation of Smyrna fig culture in the Southeastern States. Figs of the Smyrna type were matured at five different places in as many States as a result of a small distribution of caprifigs from a tree at Brunswick, Ga., which has carried the *Blastophaga* now for three years. The Smyrna trees thus made productive were old seedling trees that had never previously matured a crop.

#### NEW CITRUS FRUITS.

The breeding of citrus fruits and stocks resistant to citrus canker for use in the Gulf coast region continues to be of leading interest and importance. The behavior of the principal varieties of Satsuma and other Mandarin oranges grown in the Orient is being observed at testing stations at Los Banos, P. I., and at the Canton Christian College, Canton, China, while numerous hybrids made in this country have been sent to those stations, where canker susceptibility can be observed under natural conditions. Inoculation experiments in co-operation with the Alabama Experiment Station have also been in progress, giving verification in a number of cases of the resistance offered by certain hybrids and varieties to canker infection. The citrangequat (a citrange-kumquat hybrid) is apparently fully as immune as the kumquat and makes a good stock for the Satsuma and other citrus varieties. Severinia, a citrus relative, has proved to be entirely immune and offers considerable promise as a citrus stock and as a hedge plant to replace the susceptible trifoliate orange.

*Siamese pummelos*.—The canker resistance shown by certain forms of the Siamese pummelo seems quite well established by field observations in the Orient as well as by inoculation experiments. At least two of these pummelos are of excellent quality and good appearance, while being normally seedless. An early introduction of a supposedly

seedless pummelo from Siam proved disappointing, the fruit proving to be very seedy when grown in a mixed planting. Recent investigations in Siam indicate that seed production is dependent on the flowers becoming pollinated by seedy varieties of citrus. Authentic bud wood of the best Siamese varieties has been secured to permit a further test of these pummelos in America.

*Eustis limequat*.—Among the numerous citrus hybrids developed in the breeding investigations is one originating as the result of a cross between the common lime and the kumquat which gives promise of achieving considerable economic importance. The fruit resulting from this cross, called the limequat, has the acid flavor of the lime and yet possesses much of the hardness of the kumquat. The lime, as is well known, is so tender that its culture is chiefly limited to the coast keys of Florida, so that a hardy lime, such as the limequat promises to be, will fill a much felt want in the citrus-growing section of the Gulf coast. The limequat is handsome in appearance, vigorous in growth, and of everbearing habit, producing fruit for a considerable portion of the year. A selected hybrid of this class has been named the "Eustis," the original cross-pollination having been made at Eustis, Fla. It is being propagated commercially and should find a place in home fruit gardens in Florida and throughout the Gulf coast region, and possibly for more extended commercial growing when fully tested.

#### TOBACCO.

Work with tobacco in the Connecticut Valley during the year has been limited to a careful study of "tobacco-sick" soils. There are numerous fields which have previously yielded satisfactory crops of tobacco but have now become unproductive. It is found that the well-known *Thielavia* root-rot is only partly responsible for the trouble, and apparently a second parasitic organism is involved. In the Burley district of Kentucky the resistant strains of the older type of White Burley have given satisfactory results in the presence of the *Thielavia* root-rot, and some of the farmers are growing these strains on diseased land. Work has been continued in developing disease-resistant strains of the newer "stand-up" type of Burley, for which there is an increasing demand in the smoking-tobacco industry. In Wisconsin a strain of cigar-binder tobacco highly resistant to root-rot which has been recently developed is becoming quite popular with growers, and it has been estimated that 2,500 acres of this strain will be grown this season.

Field experiments have been continued with a view to working out the fertilizer requirements of the principal types of tobacco, and some of these tests are about completed. The results of extensive tests with flue-cured tobacco in Virginia, North Carolina, and South Carolina extending over a period of 10 years are now being prepared for publication. These tests will furnish information as to the most profitable forms and rate of application of nitrogen, phosphoric acid, and potash and as to the value of lining the soil for the tobacco crop. Beginning this year, these investigations have been changed in scope so as to cover a comprehensive field study of crop rotation in connection with the more important fertilizer problems. Fertilizer tests similar to those in the flue-cured districts have been continued in Maryland, Tennessee, and the Onondaga district of New York, and

the results of several years' work in these sections will be made available a year or two hence for the benefit of the growers.

In a series of cropping tests data of importance have been secured as to the relationship of tobacco to other crops grown in rotation with respect to the quality of the tobacco produced as well as the yield of tobacco and the other crops. These data will be of great value in arriving at a correct estimate of the proper position of tobacco in the farming system. In this work it has been found that the action of fertilizers on the tobacco crop is greatly influenced by the other crops in the rotation, and the character or extent of these influences could not be predicted from previous knowledge of the subject.

It is believed that the problem of securing an adequate supply of seed of the Maryland Mammoth tobacco has been solved through the discovery that seeds are readily produced when the plant is exposed to the action of a reduced length of day during its development, such as prevails in southern Florida during the winter months. This variety of tobacco is very popular among Maryland growers, but hitherto it has not been possible to secure seed in quantity, since the plant is normally sterile when grown in northern latitudes. In the so-called "old belt" of the flue-cured tobacco district the method of harvesting by picking the leaves from the stalk instead of cutting the stalk at its base, with the accompanying feature of high topping, which was recently introduced by the bureau, is rapidly coming into general use. It is estimated that in Granville County, N. C., where the method was first introduced, fully 90 per cent of this year's crop will be thus harvested, adding from \$1,000,000 to \$2,000,000 to the value of the tobacco crop of the county.

## NEW CROP PLANTS AND CROP EXTENSION.

### BINDER-TWINE FIBERS.

Work begun in 1917 in cooperation with the Philippine Bureau of Agriculture has been continued. The introduction of three fiber-cleaning machines by the two Governments, for the purpose of demonstrating the efficiency of machines as compared with water-retting and hand-cleaning methods used heretofore in the Philippines in the preparation of Manila maguey and sisal, has resulted already in the purchase by private capital of 12 other machines. These large machines, having a capacity of 1 to 2½ tons of clean dry fiber per day, are being built in this country and forwarded and installed as rapidly as possible. This will change the industry within a short time from hand-cleaning to a machine-cleaning basis, producing fiber of much better quality and with possibilities of much greater quantity.

A half million sisal plants have been introduced from Hawaii, and nurseries are being established in the Philippines to insure a future supply for planting. The Philippine Government has assigned a man to encourage the industry, and improvements are being made in the methods of planting and taking care of the plantations.

The production of Manila maguey and sisal in the Philippines, amounting to more than 9,000 tons during the first five months of 1920, was approximately equivalent to 20 per cent of the total pro-



duction of henequen fiber in Yucatan during the same period. Comparatively little of the Philippine fiber was machine cleaned, for very few of the new machines ordered have been installed ready for operation, but it indicates that a production of considerable proportions may be expected with the added impetus of machine cleaning.

In the Dominican Republic our investigations, including a small trial planting, have resulted in the preparation of plans and the beginning of actual work for a large commercial plantation of henequen.

In Porto Rico 600,000 sisal plants have been set out on one plantation, to which many thousands are being added each year, while the earliest ones have reached the stage of fiber production, and two other commercial plantations are being started.

The development of improved strains of sisal and henequen by selection in Porto Rico, begun in 1917, is showing very promising results. Marked differences are observed in the progenies of different selected parent plants, while the bulbils and suckers of all appear to be superior to the average unselected stock. Some of these plants are being set out in commercial plantations for comparison.

#### HEMP.

The relatively high prices for other crops, combined with the scarcity of farm labor, has brought about a decrease in the acreage of hemp, especially in Kentucky, where the fiber is broken out and hackled by hand. An important limiting factor in hemp cultivation during the last two years has been the insufficient supply of seed of good quality. Efforts are being made to encourage hemp-seed production in new areas, and trials are being made this season (1920) at several points in Missouri, Texas, and California, while seed of improved strains has been furnished to the hemp-seed growers in Kentucky to encourage increased production there.

The work of breeding improved strains of hemp is being continued at Arlington Farm, Va., and all previous records for height of plants, either individual or average for plats, were broken in the selection plats of 1919. The three best strains, Kymington, Ching-ton, and Tochimington, averaged, respectively, 14 feet 11 inches, 15 feet 5 inches, and 15 feet 9 inches, while the tallest individual plant was 19 feet. The improvement by selection is shown not alone in increased height but also in longer internodes, yielding fiber of better quality and increased quantity.

Seed of these pedigreed strains has been sent out to hemp-seed growers, as in former years, increasing each season the proportion of hemp of improved varieties.

#### FLAX.

The price of flax fiber is relatively higher than that of any other vegetable fiber on the market, being at present four to five times the prewar quotation. This is due to the fact that the supplies from Russia, formerly 80 per cent of the world's production, are now almost completely cut off. The 6,000 acres devoted to fiber flax in Michigan, Wisconsin, Minnesota, and Oregon in 1920 show an in-

crease of about 20 per cent over 1919, and owing to better seasonal conditions the outlook for a good yield of fiber is very much better.

Semicommercial test plats of pedigreed strains developed by five to ten years of selection made an excellent showing in commercial flax fields in eastern Michigan in 1919. The increased vigor of the plants, giving an increased yield of fiber and fiber of better quality, was plainly marked.

Efforts are being made by means of increase plats in Michigan and Wisconsin in summer, and in Porto Rico in winter, to secure increased supplies of these improved strains.

The plant-breeding work with flax is being continued by direct selection and also by cross-pollination, with a view to securing further improved strains. Marked differences in the vigor of plants, height, resistance to lodging, resistance to disease, and in yield and character of fiber are secured without great difficulty, but the increase of seed of improved strains is necessarily slow.

Fiber flax in this country is less affected by diseases than seed flax, but there has been some loss from wilt, rust, and canker. A study is being made of the diseases, and preliminary work is being started with a view to the development of disease-resistant strains.

#### PROMISING NEW VEGETABLE CROPS.

The dasheen continues to grow in importance in our Southern States; while in 1919 the total estimated area planted to dasheens was 150 acres, in 1920 the acreage exceeds 400, individual plantings being increased in size. One large stock raiser in Florida has planted this year 160 acres, he having found in 1919 that the dasheen made a valuable stock feed. Over 1,600 distributions of dasheens were made to experimenters in 1920. Most of this crop is used where grown for human food, stock feed, and seed for planting. Larger commercial shipments are being made each year to northern markets. Two carload shipments from the 1919 crop were sent north, while there was only one such shipment from the 1918 crop. New ways of using the dasheen have been developed, and one manufacturer of potato chips (in Washington, D. C.) has become deeply interested in the dasheen for the production of chips. These look very much like the "Saratoga" chips made from potatoes, but are superior to them in quality. This manufacturer is firmly convinced of the potential commercial value of dasheen chips and has arranged to put them on the market when a supply of dasheen tubers becomes available this fall.

*Tropical yam (Dioscorea sp.).*—The prohibition of further commercial importations of tropical yams, on account of the danger of the introduction of a very injurious root weevil, resulted in a demand for the production of these yams in the Southern States. Previous tests had shown that some varieties were adapted to southern Florida, and experiments looking toward the more rapid propagation of these were at once begun. Additional varieties have been secured from the Tropics and will be tested to determine their adaptability to the climatic conditions of Florida. Plantings on a commercial scale have been made by a grower at Brooksville, Fla., who has 5 acres in yams this year. The establishment of a tropical yam industry is apparently assured. The yam yields heavily when given proper conditions, and as it can be grown in many situations where neither

sweet potatoes nor white potatoes can be raised profitably it will be of definite value as a supplement to the other starchy root crops.

*Chayote*.—Quite a lively interest in the chayote as a southern winter vegetable has developed, and wherever fruits have been sent for cooking tests they have brought forth high commendation. Trial shipments of the fruits have been sent to many of the larger hotels throughout the Eastern States, and the inquiries for these fruits have justified an effort on the part of the department to stimulate increased production so as to care for the demand for this vegetable. From the chayotes grown at the Brooksville Plant Introduction Field Station a sufficient quantity of seed was grown to supply enough for trial tests by 2,000 cooperators. Experiments have been carried on with different fertilizers and different methods of propagation and selection so as to learn whether it is possible to segregate and keep pure some of the more desirable types.

*Rumex*.—Seeds of a very interesting vegetable known as *Rumex abyssinicus* were received from Angola, Portuguese West Africa. This is a luxuriant tropical *Rumex*, the leaves of which can be used in a way similar to spinach. Trial plantings at the Yarrow Plant Introduction Field Station have proved very successful. The plants grow in one season to a height of from 6 to 7 feet and all during the hot summer months afford an abundant supply of succulent green leaves. This plant appears to be especially promising as a hot-weather green-leaved vegetable for the Southern States, where the summers are too hot for the cultivation of spinach.

*Two starch-producing plants*.—There were grown during the past season at the plant introduction field station at Brooksville, Fla., two starch plants, namely, *Canna edulis* and *Maranta arundinacea*. The roots of both of these plants yield very valuable starches. Plant material of both has been distributed throughout southern Florida to interested experimenters, and it would appear from trial plantings that *Canna edulis* is likely to prove a very valuable crop for some of the reclaimed Everglade lands.

### DRY-LAND AGRICULTURE.

The cropping season of 1918 was characterized by extreme drought in the southern Plains and in parts of the extreme northern Plains. During the crop season of 1919 the southern and central Plains enjoyed heavy production, but the drought extended and became more extreme in the northern Plains, resulting in complete crop failures over extensive areas in parts of Montana, North Dakota, South Dakota, and Wyoming.

The soundness of the advice given farmers in the past by the Bureau of Plant Industry has again been fully vindicated by the experiences of this severe, extensive, and protracted drought, and, moreover, it has been brought home to the farmers more effectively than ever before. The self-seeking land boomers, exploiters, and theorists, with their panaceas for all the agricultural ills of dry farming, who were so numerous and so pernicious for about 20 years—from about 1895 to about 1915—have almost entirely disappeared. At the present time there is practical unanimity among all the investigators of the United States Department of Agriculture, the State experiment stations, and the agricultural department of the



Dominion of Canada upon the fundamental principles of dry-land agriculture. It is believed that the sane, conservative, and consistent attitude maintained by the bureau for the past 15 years has had much to do in bringing about this condition.

The results of the work group themselves in three dependent but rather distinct fields: (1) The determination of the possibilities and limitations of agriculture in each section. (2) The determination of the cultural methods by which individual farmers in each section can realize the greatest and most profitable production. (3) The determination of fundamental laws and principles of dry farming which may be applied beyond the actual zone of experimentation.

In a region of fluctuating precipitation such as the Great Plains, where conditions may vary from extreme drought and crop failure to abundant rainfall and bumper crops, it is only through the results of a series of years long enough to be representative of both the average and the extreme conditions to be met that such determinations can be made. This was recognized from the inauguration of the work, but is further emphasized by each year's extension of the record. While much is still to be desired in the way of knowledge of the possibilities of and the best methods of agriculture for this section there is now in hand more trustworthy information than has ever been available before.

The knowledge of the possibilities of agriculture or of the chances of success with a particular crop in each section was invaluable in deciding the encouragement to be given efforts to stimulate war-time production. It also provides a basis for determining the policy and action to be taken as occasions arise from time to time to encourage or direct production or to extend relief from drought or other calamity. The information at hand has been used freely by the Geological Survey in classifying public lands under recent homestead laws.

The accumulation and study of long-time coordinated results over a wide range of soil and climatic conditions is permitting the formulation of fundamental laws and relations between crop production and natural conditions of soil, climate, and vegetation applicable to a much wider field than that covered by experiments. Outside of its importance to the United States, the dry-farming problem is a vital one over a considerable area of the earth's surface. It is gratifying to note that besides having the confidence and support of our own people our work is attracting more and more the attention and study of the agriculturists of foreign Governments. During the last two years it has been under the observation of representatives of Australia, New Zealand, Canada, Palestine, Argentina, Mexico, Algeria, Tunis, and Czechoslovakia.

Good progress was made in the work of breeding and propagating horticultural plants for the northern Great Plains at the Mandan, N. Dak., field station. The first seedlings of native fruit came into bearing, and selections for quality and hardiness were made from them in 1918. This work is being vigorously prosecuted. In shelter-belt demonstration work there are now 946 farmers in Montana, Wyoming, North Dakota, and South Dakota actively cooperating with this station.

## FORAGE CROPS.

### ALFALFA.

The investigations that are being conducted with a view to testing the merits of various short-cut methods of obtaining a stand of alfalfa indicate quite definitely that such methods give very uncertain results in the Eastern States. Under very favorable conditions good stands of alfalfa can be obtained by sowing the seed with a nurse crop, and frequently in some parts of the Eastern States it is possible to obtain good stands by seeding in the early spring on cornstalk fields. However, such methods fail to produce satisfactory results with sufficient certainty to be generally recommended.

Investigations of the bureau indicate that no difficulty is experienced in getting a good stand of alfalfa in the West when the seed is sown with a nurse crop, provided moisture conditions are satisfactory; but there is no certainty at seeding time that there will be enough moisture to produce a permanent stand.

The winter of 1919-20 resulted in a high mortality in the experimental alfalfa plats at the field stations in the Dakotas and Montana. All commercial varieties were badly winterkilled. Experiments conducted at Redfield, S. Dak., and Moccasin and Havre, Mont., indicate quite definitely that alfalfa which has been harvested for seed is more susceptible to winterkilling than that which was cut for hay. .

### TIMOTHY BREEDING.

Much attention is being given to solving some of the practical difficulties that are encountered in establishing improved strains of timothy in general use. The new and improved strains that have been developed by the department in cooperation with the Ohio State experiment station have consistently proved their superiority over common commercial timothy to such an extent that it is believed that practical problems of establishing them will soon be solved satisfactorily.

### SORGHUMS.

It has been demonstrated by tests at numerous field stations that in the Great Plains the sweet sorghums will yield more silage per acre than corn or any of the common grain sorghums. Calling this fact to the attention of western stockmen has induced increasing numbers of them to use sweet sorghums as the ensilage crop.

The breeding of improved varieties of sorghum is being continued at Hays, Kans., Chillicothe, Tex., and Bard, Calif. Several new hybrids look particularly promising, and the seed will soon be available for distribution.

### SUDAN GRASS FOR SUMMER PASTURAGE.

This recently introduced grass sorghum is rapidly becoming popular as a summer pasturage, especially for dairy cows and work horses. All kinds of live stock relish it as pasturage, and it grows most vigorously during the hot summer months when other pasture grasses are drying up. The utilization of Sudan grass in this new rôle is largely the result of experiments and suggestions made by the United States Department of Agriculture.

## SOY BEANS.

The soy bean has become a crop of special importance throughout the country, which is indicated by the large acreage devoted to it in 1920 and the increased interest in the possibilities of the seed for food and oil. The introduction of new varieties by the department has been largely responsible for extending the growing area of the crop not only in the North and West but in the extreme South.

Investigations with soy beans in 1920 included the testing of new introductions, selected pure strains and hybrids, and of methods of culture and harvesting; experimenting with seed of promising varieties for human food and oil production; and extension work with selected varieties.

Breeding work with selections and introductions from China, Manchuria, Japan, and Chosen (Korea) produced a large number of promising sorts. Most of the varieties now grown in different parts of the country are the result of investigations by the Department of Agriculture. During the past year the Mandarin, Easy Cook, Aksarben, and Hoosier were placed in trade in the Northern States. In the South the Ootootan, Laredo, and Biloxi are being widely grown.

The Biloxi, Virginia, Manchu, Black Eyebrow, Mandarin, Hahto, Easy Cook, and Wilson Five were distributed over a wide territory in 1920, and most favorable reports were received. The Virginia, in a test of varieties in the orange orchards of California, gave the best results and promises to be an excellent summer green-manure crop. The Hahto and Easy Cook varieties have proved valuable for food both as a green vegetable and as dried beans. In addition to investigations of forage and food value, breeding work was conducted with varieties with a view to develop a high content of oil and protein.

## COWPEAS.

Extensive work with hybrids, selections, and introductions was continued with the cowpea. Investigations involving a large number of hybrid selections have developed several promising sorts which were tested throughout the cowpea region and appeared superior to many of the standard varieties. Extensive tests with the new hybrid developed by the bureau, the Victor, show that this new variety is highly resistant to the wilt and nematode diseases in the South and superior to other resistant sorts in yield of grain and forage. Hybrid and variety testing work with Blackeye and white varieties for food purposes has increased and has been conducted at many stations in the cowpea region. Numerous hybrids of the catjang and asparagus varieties of cowpea with resistant and other standard sorts of the common cowpea were tested.

## VELVET BEANS.

Interest in the velvet bean has continued to increase, owing primarily to the development of new early-maturing varieties and a recently evolved variety, the Bush, or bunch, velvet bean. The Bush variety is entirely nontwining in habit, and a wide distribution of seed in 1920 indicated it to be a most valuable sort, especially for the orchards in the velvet-bean region. Considerable selection work



was carried on with early-maturing strains, 100 per cent of some of which mature as far north as Washington, D. C. The introduction of new early sorts has had much to do in extending the area over which the velvet bean can be grown and therefore in greatly increasing the acreage of this crop.

#### VETCHES.

The study of vetches was continued during the past year along the same general lines as in previous seasons. Woolly-Pod vetch continues to show its superior value for the Southern States on account of its comparative resistance to the disease *Protocoronospora nigricans* and its vigorous winter growth.

Purple vetch has been found to be adapted to a wider area than was supposed, a result of which is an increased acreage in the northern coastal region of California, which promises to produce this year about 400 tons of seed. This new crop is especially well adapted for green manuring in citrus orchards of California, so this new source of seed supply is important.

Hungarian vetch (*Vicia pannonica*) has again proved its value for wet lands in experimental trials in the northwestern Pacific Coast States, and seed has been increased for extended demonstrations under such conditions.

Work with common vetch (*Vicia sativa*) and hairy vetch (*Vicia villosa*) has been continued, with a view to making seed available at a figure so low that farmers can afford to use these species more generally.

#### SWEET CLOVER.

The date-of-seeding tests carried on for several years at the North Dakota station have been completed this year. The result in general shows that the earliest spring seeding gives the best results. While often the apparent stand has not varied materially from seedings made between April 12 and June 10, the hay yield has been heaviest from the earliest seedings.

#### LOTUS.

In Tennessee the plants of *Lotus corniculatus* have now established themselves and for three years have not only maintained a good growth on the poorest hillsides but have increased. The outlook for usefulness on those lands is good. On the very acid soils *Lotus corniculatus* does not thrive, but *Lotus uliginosus* seems to succeed, and further experiments with this species will be made.

#### HOP CLOVER.

A study was made of the value of the wild hop clovers in southern pastures. It was found that while these species grow and form a part of the early spring pasturage in all Southern States they are of most importance in Mississippi, Louisiana, and Arkansas. In these States they cover thousands of acres, making the best of grazing in early spring and giving way to Bermuda grass and Japan clover later.

## PASTURE INVESTIGATIONS.

The high prices of market feeds have stimulated much greater interest in the only really cheap feed, namely, pasturage. To a much greater extent than formerly farmers are practicing heavy grazing, the advantages of which were proved by the grazing experiments in cooperation with the Virginia Experiment Station and since have been demonstrated by other investigations.

*Carpet grass.*—The importance of carpet grass as the basis of pastures on the coastal plains of the South has been emphasized. The only limitation to the more extensive use of this grass is the insufficiency of the commercial seed supply. A campaign to stimulate greater seed production is now under way, and favorable results from this are confidently anticipated.

*Napier grass and Merker grass (Pennisetum purpureum).*—Both of these grasses have quickly sprung into popularity in California and in the South, but particularly in Florida. In the last-named State this grass is exceedingly productive, even on poor sandy soil. From its habit, which resembles that of sugar cane, it is better suited to use as green food, fodder, or ensilage, but very satisfactory results are reported from continuous grazing.

*Centipede grass (Eremochloa ophiuroides) and Hunan grass (Eremochloa ciliaris).*—These two very similar grasses from China are about intermediate in habit between carpet grass and Bermuda grass. During two years' tests in the South they have shown great promise both for pasture and lawn purposes. There are indications that they will be valuable on lands where neither carpet grass nor Bermuda grass grows satisfactorily.

*Bahia grass (Paspalum notatum).*—This grass from Brazil has proved to be very valuable as a pasture plant in Florida. Its rapid utilization will not be possible until the problem of seed supply is solved.

## CROP UTILIZATION.

## DRUG PLANTS.

The demand for information on the production and utilization of medicinal plants has continued unabated, but with a significant change in tone and character. This change indicates that the conservative attitude maintained by the Bureau of Plant Industry toward the commercial cultivation of drug plants has contributed to a better understanding of the practical considerations involved and that interest in drug growing is gaining ground with firms and private individuals well equipped for this type of enterprise.

The drug gardens maintained at schools of pharmacy throughout the country have continued to be centers of much popular interest, and, aside from their primary educational function, have rendered a distinct public service through the dissemination of practical information on drug-plant culture gained through actual experience.

Progress has been made in the preparation of a union list or index of the species grown in each drug garden and in facilitating the securing and exchange of propagating material.

The favorable market position of domestic essential oils during the year stimulated unusual interest in the methods and equipment

used and the costs involved in their production. To meet the increased demand for detailed information a field study of several essential oil crops was undertaken. The data collected show in the case of wormwood oil, for example, that in most cases the principal limiting factor of production is the net return obtainable from other competing farm crops.

In the laboratory a study is in progress on the distribution of the essential oil in the plant and on the metabolic processes underlying the production of the various constituents which give these oils their value.

#### OIL-SEED CROPS.

Through informal cooperation with individuals in widely separated localities field tests of several new oil-seed crops have been made. Five varieties of oil-seed hemp were tested at field stations and a quantity of seed secured for further tests on a field scale.

Important data on the technology of vegetable-oil production have been secured through laboratory and field work. A study of the production and refining of corn oil has yielded data on the cost of producing this oil and the relative profits arising from using corn germs for stock feed or as a source of oil.

A study is being made of the oil from selected strains of standard varieties of peanuts to determine their suitability for oil production when grown on various types of soil and under different climatic conditions.

In the castor-oil mill operated for the War Department at Gainesville, Fla., an exhaustive study was made of the expeller and solvent extraction process of obtaining a high recovery of oil from castor beans. The data secured on solvent extraction are especially timely, since there is at present a growing interest in this process of oil technology.

It has been determined that the mold which attacks corn under certain conditions of storage not only causes a reduction in the yield of oil, as compared with the yield of oil normally obtained from sound corn, but also causes a decided increase in the free acids and unsaponifiable constituents of the oil. The source of the discoloration and objectionable odors which sometimes develop in white soaps and certain other technical products has been traced to the oil from moldy corn used in their manufacture.

#### UTILIZATION OF AGRICULTURAL WASTE PRODUCTS.

The investigation of the waste materials of corn canneries has shown that corn cobs and husks, when properly dried and ground, can be used very satisfactorily as a stock feed.

Valuable fixed oils have been extracted from the various oil-bearing weed seeds which form the bulk of grain screenings. Although not all weed seeds separated from grain have a large oil content, several have been found which contain high percentages of oil. In case of need a substantial quantity of useful oil could be produced from the large tonnage of grain screenings annually available in this country.



## THE CAMPHOR INDUSTRY.

The work on camphor production has been continued during the past year along the lines previously followed. A series of fertilizer tests designed to cover a three-year period has been begun to determine the possibility of increasing the content of camphor in the leaves and twigs of the camphor tree.

As a result of experiments carried on for several years a satisfactory type of camphor condenser has been devised and put into operation. Essentially, this condenser is a copper or zinc chamber cooled by water sprayed upon its exterior. The steam and camphor vapors from the still enter the chamber without contact with the water used for cooling and are condensed upon the chamber walls. This condenser can be built at a moderate cost and its operation does not require technical supervision.

## POISONOUS-PLANT SURVEYS.

The identification of plants causing live-stock losses on the western ranges was continued throughout the grazing season. Surveys to determine the areas of greatest danger were made in the Datil, Gila, and Lincoln National Forests. In Arizona and New Mexico an intensive study of "loco" plants was made, since the losses from loco in those States are heavy and widespread. In the mountain or summer range one species, *Oxytropis lambertii*, causes most of the loco poisoning. In the foothills and on the plains there are many species of *Astragalus* suspected of being poisonous, but thus far only two are definitely known to be injurious. Extensive collections of material were made for laboratory study. Since there are both annual and perennial species of *Astragalus*, a critical study of the seed habits of suspected species was undertaken, with the object of facilitating the work of eradication.

Evidence has been accumulated which shows that many plants of the composite family are poisonous. Among the genera known to be poisonous in the Southwest are *Baccharis*, *Chrysothamnus*, *Dugaldia*, *Gutierrezia*, *Hymenoxys*, *Isocoma*, *Solidago*, and *Tetradymia*. A systematic study of the characteristics and distribution of these genera both in the field and in the principal herbaria of this country has been a feature of the year's work.

## CONGRESSIONAL SEED DISTRIBUTION.

During the fiscal year 1920 there were distributed on congressional and miscellaneous requests 10,333,705 packages of vegetable seed and 1,503,212 packages of flower seed, or a total of 11,836,917 packages, each containing 5 packets of different kinds of seed. There were also distributed 14,255 packages of lawn-grass seed and 11,461 packages of imported narcissus and tulip bulbs. The seeds were purchased on competitive bids, as heretofore. The bulbs were grown in the United States bulb-propagating garden, Bellingham, Wash. Each lot of seed purchased was thoroughly tested for purity and viability before acceptance by the department, and tests of each lot of seed were conducted on the department's trial grounds to determine trueness to type.

The work of packeting, assembling, and mailing the vegetable and flower seed was done by a private contractor at a cost of \$2.10 a thousand packets, including the furnishing of the packets and envelopes.

#### NEW AND RARE FIELD-SEED DISTRIBUTION.

A distribution of new and rare field seeds was made throughout the entire United States, having for its object the dissemination of seed of new and rare field crops, seed of improved strains of staple crops, and high-grade seed of crops new to sections where the data of the department indicate such crops to be of considerable promise. Each package contained a sufficient quantity of seed for a satisfactory field trial, and the recipient was urged to use the seed, if feasible, for the production of stocks for future plantings. A report card and a circular giving full directions for the culture of the crop accompanied each package of seed.

Only seed of new crops or of improved strains of standard crops were distributed, as follows: Dakota grown, Grimm, Kansas grown, and Peruvian alfalfas; Great Northern field beans; white sweet clover; Brabham, catjang, and Early Buff varieties of cowpeas; Spur feterita; Bangalia, Chang, Gregory, Kaiser, and Paragon field peas; Merker grass, Napier grass, Natal grass, orchard grass, and Rhodes grass; Dwarf Blackhull kafir; Kursk millet; Dwarf Yellow milo; Dakota Amber, Red Amber, and Sumac sorghums; Biloxi, Black Eyebrow, Easy Cook, Haberlandt, Hahto, Ito San, Laredo, Mammoth Yellow, Manchu, Mandarin, Peking, Tokio, Virginia, Wilson, and Wilson Five varieties of soy beans; Sudan grass; Bush, Georgia, and Osceola varieties of velvet beans; and Acala, Columbia, Dixie, Durango, Holden, Lone Star, Meade, and Trice varieties of cotton.

During the year 128,848 packages of new and rare forage-crop seed and 97,977 packages of cotton seed, or a total of 226,825 packages were distributed.

The Napier and Merker grasses, seed of which was distributed by the department for the first time in the past year, give promise of being exceedingly valuable for hay and silage in regions where the temperature does not fall below 20° F. Reports indicate that Spur feterita, seed of which was distributed for the first time in 1919, is proving its superiority over common feterita for grain production in large areas in the southern part of the Great Plains region. The Great Northern field bean, seed of which was distributed for the first time in 1919, is giving promise of being another crop adapted to large areas of dry-farming territory in the northern part of the Great Plains region. Largely through the medium of this distribution, the Bush velvet bean has been disseminated throughout the velvet-bean growing section of the South and is being thoroughly tested, especially as an orchard-cover and green-manure crop. This velvet bean gives promise of being a valuable variety, although whether it is satisfactory as a field crop can not be definitely determined at this early date.

Among the accomplishments in connection with this seed distribution may be specifically mentioned the putting into general use of Sudan grass throughout a large part of the eastern half of the United States, and especially in establishing it as an annual pasture grass in the southern half of the Great Plains region. This distribution

has made it possible for such a large number of farmers to get genuine seed of Grimm alfalfa that this variety is now firmly established in the Northwestern States. Much improvement has been brought about by the widespread distribution of improved grain sorghums and millets. The area of production of cowpeas, soy beans, and velvet beans has been enormously extended, in a large measure owing to the department's efforts in distributing superior varieties of these crops throughout the sections where they are generally adapted. The bureau also has been largely instrumental in bringing about the widespread use of such improved varieties of cotton as Lone Star, Trice, Durango, and Columbia.

### SOIL-FERTILITY INVESTIGATIONS.

#### A COMPARISON OF AMERICAN POTASH MATERIALS.

The materials studied have been potassium sulphate obtained from the alunite deposits of Utah, potassium muriate obtained from the Searles Lake deposits in California, potash salts obtained from the lakes of Nebraska, several grades of cement dust obtained as a by-product in the manufacture of cement, kelp, and other minor materials. The potash content of the materials from these various sources varies, but when used according to their content all of these materials have given satisfactory results. The Searles Lake product when free from borax or when the proportion of borax is very low is a satisfactory source of potash. The cement dusts contain, in addition to the potash, considerable lime, and this fact must be taken into consideration when they are used. The presence of the lime is an advantage on soils which require liming, but is a disadvantage in the mixing of fertilizers, where the alkaline character of the lime would liberate ammonia. In such cases it should be applied separately to the soil. These tests were carried out in field experiments with potatoes in the States of Maine, New York, New Jersey, Virginia, and North Carolina, and with cotton in the States of North Carolina, South Carolina, and Georgia.

#### EFFECT OF BORAX IN FERTILIZERS.

The potash deposits of Searles Lake contain borax, which, by proper methods of purification, can be reduced to a very low amount. During the war this was not satisfactorily accomplished, and borax occurred in certain shipments of this material in considerable amounts and did much damage, particularly in potato, cotton, and tobacco fertilizers, as these are often used with high potash content. Special study was made in the potato-growing regions of Maine and the cotton-growing regions of South Carolina. The effect on the potato was to interfere seriously with the stand by delaying germination, so that when healthy plants were at the blossoming stage borax-affected plants were just emerging from the ground.

The foliage is in many cases lighter green, but in the more affected cases the leaves are yellow, especially the edges of the leaves. In the case of cotton, delayed germination was also the principal effect of the borax, which resulted in a very irregular stand and consequently a much-lowered production. In view of the damage done by borax in fertilizers in these regions, the department



took this matter up with the producers and manufacturers and is limiting the content of borax in fertilizers to one-tenth of 1 per cent, unless the amount contained be clearly stated on the label for the guidance of the farmer in making the application to the soil, so that not more than 2 pounds of borax be applied per acre.

Experiments are being conducted to study the effect of borax on different soils and under different climatic conditions, using amounts from 1 pound to 400 pounds per acre and studying the effect of applying in the drill, applying broadcast, delayed planting after the fertilizer application, and the influence of rain and soil moisture by repeated plantings through a period of several weeks, during which different climatic conditions are encountered. The experiments are in progress in Maine, New Jersey, Virginia, and Alabama, and the crops grown are corn, potatoes, cotton, and beans. Corn and beans are especially sensitive to borax and begin to show reactions from 2 to 5 pounds of borax per acre, according to conditions, while potatoes and cotton show reactions from 5 to 20 pounds. When broadcasted, larger amounts are required to show injury than when drilled, and copious rainfall after application of the borax fertilizers in all cases decreases greatly the injury due to borax.

#### POTASH REQUIREMENT OF THE POTATO AND COTTON PLANTS.

The requirements of the potato and cotton plants in regard to potash have been especially studied. The decrease in potash and finally its entire elimination in fertilizers during the early periods of the war caused considerable damage locally on certain soils in the potato-growing regions of the Northeastern States and the cotton region of the Southeastern States. The plants suffered from a disease which was diagnosed as caused by malnutrition, due to the unbalanced condition of the fertilizers brought about by the elimination of potash. In the potato this so-called potash hunger shows itself in a darker green foliage, much wrinkled and distorted leaves, which later become bronzed or browned and the plant much diminished in vigor, finally succumbing to secondary infections which cause a falling of the leaves or the entire wilting and dying of the stems, with a much decreased yield in tubers, due to the early maturity and death of the vines. In the cotton plant the symptoms are somewhat similar, darker green foliage, which later rusts badly, the plant becoming finally completely defoliated at about the time the first bolls begin to mature. The younger bolls do not reach maturity, and the yield of cotton is greatly reduced by lack of potash. The extensive experiments made in the States mentioned above showed that this condition was entirely eliminated by restoring the proper fertilizer balance by the introduction of potash salts.

These experiments further showed the important point that the potash consumption in the fertilizers of prewar days was unnecessarily high, and that approximately one-half the amount of potash then used gives as good and in many cases a better balance to the fertilizer ratio for the production of these crops. This is especially true in the case of the potato-growing regions of the Northeastern and South Atlantic States, where this change in practice has already saved the growers about \$10 per acre, which means the saving of large sums in their fertilizer bills.

## PLANT-FOOD REQUIREMENTS OF IMPORTANT SOIL TYPES.

Large areas of certain soil types of the United States are devoted to important crops for which they are particularly adapted, and fertilizer studies on these important types to determine the plant-food requirements of the principal crop grown on the type are an important phase of the investigations in soil fertility. With a small beginning in 1916 on a single soil type, the work has grown steadily in scope and importance, and the demand for its extension has been such that it now covers large soil regions in the Atlantic Coast States and is encompassing regions lying farther inland. Cooperative field experiments are now in progress in Maine on the Caribou and Washburn loam; in New York on the Sassafras loam; in New Jersey on the Penn loam and Sassafras sandy loam; in Pennsylvania on the Hagerstown loam; in Virginia on the Norfolk fine sandy loam; in North Carolina on the Dunbar fine sandy loam and Portsmouth sandy loam; in South Carolina on the Norfolk fine sandy loam and coarse sandy loam, Ruston coarse loamy sand, Portsmouth sandy loam, and Coxville fine sandy loam; in Georgia on the Cecil sandy loam, Orangeburg sandy loam, Greenville sandy loam, Susquehanna and Norfolk fine sandy loam; in Florida on the Norfolk sand and fine sandy loam and Orlando fine sand; in Indiana on the Scottsburg silt loam; in Wisconsin on the Superior silty clay loam; in Arkansas on the Pope fine sandy loam. The crops grown are the main crops of the regions, representing millions of dollars of agricultural wealth and comprising potatoes, cotton, and corn, the leading money crops of the country, as well as pecans, grass, clover, sorghum, celery, lettuce, etc. The results very clearly show the difference in fertilizer requirements on the different types, some responding more readily to nitrogen than to potash or phosphate, while others show a decided deficiency in phosphate or in potash. In each case the best ratio of nitrogen, phosphate, and potash is determined, and the results are of great economic and practical value to the growers in the regions concerned. This use of the proper formula or ratio in plant foods is made of more and more importance because of the constantly increasing cost of the fertilizing materials. It has thus been possible to make recommendations which have resulted in the saving of thousands of dollars to the growers in the purchasing of properly balanced fertilizers.

## NEW FERTILIZER MATERIALS.

A study has been made of cyanamid and other nitrogen sources derivable from this product of nitrogen fixation, and the results obtained are serving as a guide in further pursuing this subject in the Government's nitrogen-fixation plants. It has been found that cyanamid in mixtures of fertilizer materials undergoes changes into other compounds, some of which appear to be much less available to plants and in some cases even distinctly harmful, so that careful supervision and control to prevent these transformations are necessary. Many other new fertilizer materials which have been brought forward as a result of the changed conditions that occur in the fertilizer materials industry have been studied. Many of these are legitimate sources of new fertilizing materials, but a great many have shown themselves to be of more or less doubtful value and in

many cases entirely worthless or even harmful. In some cases these have been tested in the field, but mere laboratory and greenhouse examinations will often give an indication of their comparative values. In this way attention has been directed to the utilization of some valuable materials, and on the other hand both farmer and manufacturer have been spared the loss of money or crops by the use of materials of doubtful value.

## PLANT DISEASES.

### ROTS OF CORN AND SCAB OF WHEAT AND OTHER CEREALS.

#### ROTS OF CORN ROOTS, STALKS, AND EARS.

Losses in the United States in 1919 from this group of corn diseases are conservatively estimated at 125,175,000 bushels, or about 4 per cent. Research on these diseases, in cooperation with the Indiana and Wisconsin Agricultural Experiment Stations and other agencies, has been directed chiefly along four lines: (1) The symptoms of the diseases, (2) relation of the condition of the corn plant to susceptibility, (3) effects of the diseases on the physiology of the plant, and (4) control measures.

*Symptoms of the diseases.*—The results in the past year have verified those of previous years by showing that the diseases reduce yields either by killing or lowering the vitality of kernels and seedlings, thus causing poor stands; also by causing barren stalks, leaning or broken stalks, and broken ear shanks.

*Relation of the condition of the corn plant to susceptibility.*—Immature or starchy seeds produce plants that are more susceptible to the attacks of these diseases than are those from seed well matured and horny. The immature and starchy ears usually have a much rougher denting than the well-matured hornykerneled ears. This discovery is unusually important, as by physical selection alone it is possible to discard a high percentage of the seed ears that would produce plants more susceptible to the disease.

Investigations show also that various unfavorable soil conditions either may produce plants having appearances very similar to diseased plants or may predispose fairly healthy plants to attacks of the diseases. An acid soil reaction seems to be associated with such predisposition to disease.

*Effects of the diseases on the physiology of the host.*—The researches indicate that the nutrition of a diseased plant is abnormal. Chemical analyses show that infected and disease-free plants vary in composition. Diseased plants often show, in and near the nodes, deposits of harmful substances which interfere with the normal functioning of those structures.

*Control measures.*—A convenient method of testing seed corn for germination and disease infection has been devised. The ordinary rag-doll germinator has been modified by combining with it an insulating sheet of heavy glazed paper. When the rag doll is rolled, this paper lies between the successive layers of cloth carrying the kernels and so prevents the growth of the rots and molds through the cloth. This confines the infection, in a large measure, to the kernels already infected and permits the certain identification of sound ears.



The rolled dolls are placed in a double-walled box and kept at the proper conditions as to temperature and moisture during germination. The use of the table germinator has been found satisfactory where the necessary equipment is available.

An extensive study of different varieties and strains of dent and sweet corn is under way at several places. Different strains of Reid's Yellow Dent are being grown in parallel rows at two points in Indiana, and marked differences in susceptibility apparently exist in different strains.

Breeding experiments in Indiana show that tendencies toward susceptibility can be concentrated by selfing ears on diseased plants. Resistance and susceptibility appear to be inherited characters.

The most important result from the standpoint of control measures is the fact that a high percentage of the diseased or predisposed seed ears can be detected by their physical characteristics and so discarded from the seed stock. The physical characteristics are of two classes: (1) Those of the kernel and (2) those of the ear-shank attachments.

It was found that the most susceptible corn plants resulted from kernels either immature or unduly starchy and with very rough denting. Vice versa, the most nearly disease-free seed and that producing plants showing the highest degree of resistance was found to be horny and bright in appearance and with rather shallow denting. The healthiest ears are those whose ear-shank attachments do not show cracking, shredding, discoloration, or any evidence of moldy growth when the outer end is cut off with a sharp knife. The ear-shank attachments of the best ears are rather firm and clean. A description of control measures that may now be applied by farmers has been prepared for publication.

#### FUSARIUM BLIGHT, OR SCAB, OF WHEAT AND OTHER CEREALS.

*Losses caused.*—It is estimated that this destructive disease caused almost as heavy losses of wheat in 1919 as did the black stem rust. The loss of cereal crops, due to blight, or scab, is estimated to be approximately 59,681,000 bushels of wheat, 927,000 bushels of barley, 39,000 bushels of rye, and a considerable quantity of oats not definitely estimated. The total estimated loss was a little over 60,000,000 bushels of grain. The disease was distributed practically throughout the Mississippi Valley and eastward to the Atlantic coast, but was most severe in the corn-belt States.

*Host plants.*—The disease attacks all the cereals and a number of other grasses. Various organs of the host may be attacked by the disease, principally the heads, but also the root systems and bases of the stems of seedlings.

*Causal fungi.*—Extensive investigations show that several different fungi produce wheat scab, but that *Gibberella saubinetii* causes the major losses. It also is one of the causes of corn rot in the corn belt. In a series of studies made from over 1,000 specimens of scabby wheat from 15 States, this fungus was found to be the pre-dominating organism present. Less than 1 per cent of the specimens yielded *Fusarium culmorum*, *F. avenaceum*, and other *Fusarium* species.

*Sources of infection.*—It was found that the most important source of infection for wheat blight, or scab, was old cornstalks carrying the

common wheat-scab organism *Gibberella saubinetii*. It was repeatedly found producing spores in great abundance on old cornstalks in wheat fields where corn had been the preceding crop. It occurs also on other crop refuse, such as grain and grass stubble. Investigations indicate that infected seed is the source of infection for the seedling blight referred to above but is not an important source for head blight.

*Influence of soil temperature.*—Soil temperature following seeding time has an important influence on the development of seedling blight of wheat wherever the organism is present. Less seedling blight occurred when sowings were made in cool soil than when they were made where the soil temperatures were comparatively high.

*Control measures.*—The control of blight, or scab, of wheat, as well as that of other cereals, is not simple. In the case of wheat, the best possible seed of the best adapted variety should be obtained, thoroughly cleaned, and given the formaldehyde seed treatment. It should then be sown when the soil is comparatively cool on land free from old infected cornstalks. Crop refuse and grasses at the edges of the field and in near-by waste places should be cleaned up. There is some indication but no conclusive proof that some wheat varieties are less susceptible than others.

#### TAKE-ALL DISEASE OF WHEAT.

*Occurrence and severity of take-all.*—This disease recurred to a limited extent in both Illinois and Indiana in 1920. In the few cases where the highly susceptible varieties of wheat were sown, the disease was very severe, causing a reduction in yield of about 75 per cent. Fortunately but very little seed of these varieties of wheat was sown in the infested sections.

*Resistant and susceptible wheat varieties.*—An extensive series of wheat varieties was grown to determine their comparative susceptibility. The so-called Salzer's Prizetaker and the Red Cross varieties showed a very high degree of susceptibility: Illini Chief was moderately affected, while no other varieties showed more than 2 per cent of infection and several were entirely free from the disease. Among the standard varieties which are either highly resistant or immune are Turkey, Red May, and Red Wave. The use of the best adapted of these varieties in the infested areas is the most practicable means of controlling the disease. The regulations being enforced in the infested areas do not permit the sowing of the susceptible varieties named.

#### FLAX DISEASES.

##### TWO TYPES OF CANCER ON FLAX.

Investigations in cooperation with the North Dakota Agricultural Experiment Station have shown that there are two distinct types of the so-called flax canker, one of a nonparasitic nature and the other caused by a parasitic fungus. The nonparasitic type usually is most conspicuous in flax-growing sections of North Dakota and Montana. It manifests itself by enlargement of a portion of the base of the stem and a weakening of the stem just below this enlargement, so that the attacked plants usually break over and become

worthless. It has been found that this trouble is caused by high soil temperatures at the soil surface when the flax plant is from 1 to 4 inches high.

The parasitic flax canker previously reported in North Dakota and found during 1920 in fiber flax in Michigan is caused by a fungus belonging to the genus *Colletotrichum*. This disease is known to occur in fiber-flax sections of Ireland and Holland, where it sometimes becomes important as a seedling blight.

Control measures have not yet been determined for either of these diseases.

#### BARLEY "SCALD," AN IMPORTANT DISEASE IN THE WEST.

For several years a disease of barley, becoming known as "scald," has been destructive, especially in certain parts of California, Oregon, and Washington. The disease destroys the leaves, reduces the size of heads, and causes shrinkage of kernels on affected plants. It is caused by the fungous parasite *Rhynchosporium secalis*.

Investigations carried on in cooperation with the California Agricultural Experiment Station indicate that certain selections from the barley varieties Mariout and Tennessee Winter show resistance to the disease, while all other varieties under experiment were very susceptible.

#### THE NEMATODE, OR EELWORM, DISEASE OF WHEAT.

*Distribution and crops attacked.*—The nematode, or eelworm, disease of wheat and rye has been found in 52 counties in Virginia, 10 in West Virginia, and 1 in Georgia, and is thought to be present in some counties in North Carolina and in southeastern Ohio. Losses as high as 70 per cent of the wheat crop have been reported from farms in Virginia. In several cases rye was found to be damaged equally as much. Emmer and spelt also are very susceptible to the disease. Repeated efforts to inoculate various varieties of barley and oats have met with very little success, so that these cereals may be regarded as practically immune. Corn and the various grasses commonly grown have been found free from attack and may be safely used in the rotation.

*Spread.*—The principal and only important method of spreading this pest is by means of the galls in the seed. In the soil the organisms are unable to travel laterally more than 4 inches unless carried by the washing of soil water. Vertically, however, they have been found capable of infecting wheat at a distance of 10 inches. This makes deep plowing ineffective as a means of control.

*Control.*—Experiments conducted at several points in Virginia on badly infested land prove that the organism is killed in the soil in one year by sowing some crop which it can not infect. Land badly infested in 1918 was sown to grass in the fall, and wheat was sown again in the fall of 1919. The resulting crop in 1920 was entirely free from infection. Among the half hundred varieties of wheat which have been inoculated with this disease only one (Kanred) has been found to show any appreciable degree of resistance. Less than 1 per cent of this variety was infected, while the other varieties showed infection varying from 20 to 90 per cent. However, Kanred is a hard winter wheat, not suited at all to the region where the nematode disease prevails.



## BLACK STEM RUST OF WHEAT AND OTHER CEREALS.

Research on this widespread and destructive disease has been continued, in cooperation principally with the Minnesota Agricultural Experiment Station.

## EPIDEMIOLOGY STUDIES.

Epidemiology studies were made to ascertain the source of initial infection in the spring and to determine the conditions under which rust develops and spreads most rapidly. The three possible sources of rust in the spring are: (1) Red spores (urediniospores which overwinter in the North), (2) red spores which overwinter in the South and from which infection spreads gradually northward, and (3) yellow or cluster-cup spores from the common barberry. Extensive investigations show that while the red spores overwinter abundantly as far north as Oklahoma there is no proof that any overwinter normally in the Northern States. There is, however, some circumstantial evidence of local overwintering near Madison, Wis., in 1920.

The common barberry became infected as far south as Wichita, Kans., and southern West Virginia. Very little infection was found in Kentucky and Missouri, and none at all south of these States. The fact that it rusts very little south of about the latitude of 39° N. is due to loss of viability before spring by the black spores (teliospores) in the South. In the Northern States the common barberry becomes heavily infected and is a most important factor in spreading the black stem rust. The development of local epidemics in the upper Mississippi Valley in 1919 and 1920 has been shown to be due largely to early spring infections of the common barberry and the spread of the rust from them to adjacent grasses and grain fields. Such infection begins very early in May, and if conditions for rust development are favorable infection may become widespread by the middle or latter part of June. This is early enough to permit severe injury to spring wheat, though usually too late to cause much damage to winter wheat.

Important results have been obtained in the study of the possible effect of native barberries and the closely related forms sometimes called Mahonia. Only one species of native barberry (*Berberis canadensis*) rusts abundantly enough to be dangerous. This species causes wheat rust in West Virginia and some portions of adjacent Virginia. The Mahonia of the Rocky Mountains (*M. repens* or *B. repens*), which is found in the mountainous portions of the eradication area in Colorado, Wyoming, and Montana, apparently does not rust when growing wild and has not yet been infected in the greenhouse tests. The taller species of the Pacific Northwest, known as the Oregon grape (*M. aquifolium* or *B. aquifolium*), which is sometimes cultivated as an ornamental, has been infected by artificial inoculation in the greenhouse and should not be planted in the eradication area.

## BIOLOGIC FORMS.

Steady progress has been made in the study of biologic specialization. These biologic forms can be distinguished from each other only by their action on varieties of wheat, some being able to attack certain wheat varieties and unable to infect others. At least five can

be distinguished by their action on Marquis wheat alone. Up to date, at least 22 distinct forms have been identified. Some of these occur commonly over rather large areas, while others are less common and occur in restricted districts. These facts explain why a certain variety of wheat may be resistant to rust in one place and not in another. Investigation shows that these rust forms apparently do not change their characters rapidly, so that after a variety of wheat resistant to a certain form is developed it will remain resistant to that form.

#### BARBERRY ERADICATION.

The campaign for the control of the black stem rust of wheat by the eradication of the common barberry, begun in the spring of 1918, is now in its third year. Included in the area are 13 of the North-Central States, namely, Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming. State laws requiring the removal of common barberry bushes have been enacted in all of these States except Wyoming. The campaign is conducted in cooperation with the State agricultural college in each of the States and with the State department of agriculture in many of them. The different phases of the campaign, namely, education, location, and eradication, have been continued in each State.

#### LOCATION SURVEY.

In a systematic survey of cities and towns 168,478 bushes were located on 12,836 private and public premises during the year. Survey of nearly all cities and towns of over 300 population has been completed. An intensive farm-to-farm survey is being carried on. This has proved to be the largest and most important part of the campaign. In the counties covered at least 20 farms per county have had cultivated barberries. In approximately 50 counties all rural properties have been inspected; 1,897,374 bushes were located on 4,394 rural properties. In visiting these properties 129,850 miles of country road were traversed. The location of escaped barberries in woodlands and pastures is a large problem. In the past year 1,674,034 escaped bushes were found scattered over 1,142 properties.

Along with the original survey a resurvey is conducted in order to determine what bushes have not been removed in accordance with notices served on owners and to determine where sprouts have developed from roots of bushes that were not properly dug, or seedlings have grown from berries and seeds scattered in digging or by birds. In this resurvey 123,246 bushes and 24,000 sprouts were found remaining on 1,614 properties. Most of these have been removed since. A second resurvey is essential, and a third is sometimes necessary to make absolutely sure that no bushes are left.

#### ERADICATION.

Of 2,065,891 bushes found on 17,203 properties during the past year 1,994,366 were reported removed from 12,618 properties. During the early days of the campaign approximately 1,400,000 bushes were removed from nurseries, parks, railway rights of way, and other public and private properties by means of publicity and other

interested agencies. No definite records of these were obtained. Records to date show that a total of 2,465,426 bushes have been located on 36,568 properties and 2,305,142 have been removed from 26,269 properties, making a grand total on June 30, 1920, of 3,865,426 bushes located and 3,705,142 bushes removed.

#### LEAF RUSTS OF WHEAT, BARLEY, AND RYE.

Research on the various leaf rusts is conducted in cooperation with the Indiana Agricultural Experiment Station and, to a limited extent, with other State experiment stations.

#### LIFE HISTORIES, BIOLOGIC FORMS, AND HOSTS OF LEAF RUSTS.

Greenhouse research has resulted in the production of the æcial stage of the leaf rust of wheat, thus for the first time demonstrating the complete life cycle of this rust. These results show that various species belonging to one genus of the family Ranunculaceæ are the alternate hosts for the leaf rust of wheat. The leaf rust of rye also has been carried through its complete life cycle in the greenhouse, and the results obtained by other workers have been duplicated and somewhat extended, æcia being produced for a considerable period of time on *Anchusa officinalis*.

Considerable progress has been made during the past year in the studies to discover biologic forms of the leaf rusts. At least two apparently quite distinct strains are present in the leaf rust of wheat in this country. The leaf rusts of rye and barley so far have given negative results. The work of the previous seasons upon hosts and relationships of the leaf rusts has been extended and amplified, resulting in a better understanding of the relationship of the forms on cereals and the related forms of these rusts on grasses.

#### WHEAT VARIETIES RESISTANT TO LEAF RUST.

Field and greenhouse experiments during the past two years have resulted in the discovery of a number of wheat varieties which are fairly resistant to leaf rust. Of the various wheat subspecies or groups, the clubs have been found to be extremely susceptible, the spelts and poulards usually only moderately infected, while the durumms, emmers, einkorn, and Polish wheat, on the other hand, are generally rather highly resistant.

In the 300 or more varieties and selections of the bread wheats studied, all gradations were found from extreme susceptibility to almost complete immunity. The most resistant of these wheats were discovered in a number of varieties belonging to the Crimean group. Of these, five were found which have shown a high degree of resistance in greenhouse and field, especially so in the eastern and southern localities. These varieties are Malakoff, C. I. 4898, and four selections of a Turkey  $\times$  Bearded Minnesota hybrid. The various Kanred selections have shown a high degree of resistance in sowings made in Wisconsin, Illinois, Indiana, and Tennessee and at the Arlington Experimental Farm, near Washington, D. C. Besides these, about 10 or 12 other hard winter wheats have shown considerable resistance to leaf rust, and, what is more important for southern conditions, several soft winter wheats have shown considerable promise of resistance, which it is hoped may be increased by selection.



## THE PHILIPPINE DOWNY MILDEW OF MAIZE.

Good progress was made in the investigation of the extremely destructive downy mildew of maize in the Philippine Islands. There are several downy mildews in the Orient which have attracted increasing attention recently because of their widespread destruction of maize and related crops in the East and their threatened invasion of our own country. The Philippine species is the most immediately dangerous of the group. It was found that this maize mildew is generally distributed throughout the thousand-mile extent of the scattered Philippine Islands, thriving even in districts of higher altitude where the climate closely approximates that of our Southern States.

This downy mildew is the most destructive of all known corn diseases. In the Philippine Islands it commonly causes losses of from 30 to 70 per cent and at times destroys all but a very few plants in extensive fields. In some districts it is so severe that it has caused the abandoning of corn culture for other more fortunate crops.

Detailed information was obtained on many baffling points in the hitherto obscure life history of the causal fungus. At least two strains were found to be involved. Conidium production and the consequent spreading of infection were discovered to take place only at night, and even then only when the plants were covered with a thin layer of moisture.

Under favorable conditions the downy mildew was found to spread with very great rapidity. The spores are distributed by wind over considerable distances; and, once started, the plant-to-plant infection is progressively destructive, because the diseased individuals begin producing large numbers of conidia within one or two weeks. To make matters worse, this conidium production may continue for more than two months, and corn in the field is susceptible for six or even eight weeks. When attacked, the plants are almost invariably rendered quite barren, and as a rule they also are so stunted, weakened, and deformed as to be useless for fodder even if they survive.

By extensive inoculation experiments it was learned that the disease apparently attacks all varieties of maize with equal virulence. It also attacks teosinte, some sorghums, sugar cane, and *Saccharum spontaneum* and *Miscanthus japonicus*, two widely distributed wild grasses of the Orient, which serve to maintain the disease from crop to crop even in the absence of maize.

Two types of spores were encountered, the fungus forming, on sugar cane and these wild grasses, not only conidia but also heavy-walled spores which are extremely resistant. The latter could easily withstand sufficiently long transportation to enable them to reach the United States on introduced plants, seeds, or packing. The connection between the two types of spores has not yet been definitely established, but in the Philippines the resistant spores are not necessary to the continuance of the disease.

Because of the extensive distribution of these two wild grasses, it is practically impossible to eradicate the downy mildew from the Philippines or from the Orient as a whole, but in the United States where the grasses do not occur this probably could be accomplished. However, means of control were devised which, even in the Philip-

pinces, were successful in reducing the disease to a negligible minimum or even entirely excluding it on small controlled areas.

The results of this research are being prepared for publication, the first paper in the series having been issued.

#### CEREAL SMUT INVESTIGATIONS.

These investigations were conducted in cooperation with the agricultural experiment stations of the States mentioned in the text.

##### BUNT, OR STINKING SMUT, OF WHEAT.

*Wheat varieties resistant to bunt.*—An extensive series of wheat varieties was sown in smut nurseries located at Pullman, Wash., and Moro, Oreg. All the seed was inoculated with spores of *Tilletia tritici*, the common species in that section of the country. Practically all the wheat varieties under experiment proved susceptible, a few showing 100 per cent of infection. On the other hand, a few varieties—notably Florence, Wardoo, Kanred, Kharkov, and White Odessa—showed a high degree of resistance. Numerous selections of different varieties belonging to the Crimean or hard winter wheats also showed low percentages of infection. The prospect of developing resistant varieties is very promising.

*Seed injury resulting from treatment against bunt.*—Experiments in controlling bunt by various methods of seed treatment were undertaken at field stations in New York, Virginia, Texas, Kansas, Montana, Washington, Oregon, and California. The usual treatments with copper sulphate and formaldehyde were very effective, resulting in the control of bunt and increased yields from the treated seed compared with untreated checks. Treatment by the dry formaldehyde method, however, has not been satisfactory, due partly to resulting seed injury and partly to failure to control bunt.

In the semiarid West severe injury to the vitality of seed wheat frequently follows treatment against smut. This injury has been investigated and the cause determined. The principal factor is found to be the cracking or chipping of the seed coats of the kernels in thrashing. Under dry-land conditions the seed coats are much more brittle than under humid conditions, which accounts for the occurrence of this injury in the West. When wheat seed with mechanically injured seed coats is treated with copper sulphate this chemical may kill the embryo by penetrating through the broken seed coat. Such injury may be prevented in part by dipping the treated seed in a lime solution to neutralize the copper sulphate remaining on or in the seeds.

The commonly used formaldehyde treatment also has resulted in severe injury to wheat seed in the West. This injury is found to be due to the drying of the kernels after treatment rather than to the treatment itself. Under certain conditions of drying, the formaldehyde present on the seeds is precipitated as paraformaldehyde. When the seed is sown, the paraformaldehyde passes back into solution and causes the injury. If treated seed is thoroughly rinsed in water, no injury occurs.

##### LOOSE SMUT OF WHEAT.

Further progress has been made in the development of central treating stations where the farmer may bring his seed wheat for

treatment. Several of these were established in Indiana in 1919, and many farmers had small lots of grain, usually 5 to 10 bushels, treated for the fall sowing.

The results of the treatment have proved very satisfactory. In general, loose smut was not so prevalent in 1920 as in previous years. However, the wheat from untreated seed usually showed from 5 to 12 per cent of loose smut, while occasionally even higher percentages were recorded. On the other hand, wheat grown from the same seed but treated by the hot-water method proved practically free from loose smut.

Much remains to be done to simplify and cheapen the methods of treatment. Experiments are in progress on the drying of the seed grain following treatment, the improvement of the apparatus used, and the determination of the comparative values of steam and hot water. Interesting results have been obtained on the effect of different modifications of hot-water and steam treatments on seed injury and on the control of loose smut.

#### LEAF SMUT OF WHEAT.

*Distribution of leaf smut.*—Leaf smut, or flag smut, of wheat has been found to be more abundant in Madison County, Ill., this year than in 1919, when it was first reported. Last year it was found in 33 fields, comprising about 825 acres. Usually only a trace of the disease was present, though occasionally as much as 1 to 2 per cent was found. This year leaf smut has been found in 111 fields, comprising about 2,500 acres. These fields, however, are confined to an area of about 47 square miles, which was quarantined last year on account of leaf smut and the so-called take-all. Usually the percentage of infection is low, but in parts of some fields it runs as high as 15 to 20 per cent.

Fairly good evidence has been obtained for the occurrence of soil infestation. The problem of control is increased on account of the occurrence of viable spores in the soil as well as on the seed.

*Varietal resistance of wheat.*—In the experimental field near Granite City, Ill., records were obtained on the resistance of 71 varieties or strains to leaf smut. The most susceptible varieties proved to be Dawson (Dawson Golden Chaff), Fultz, Jones Winter Fife, K. B. No. 2, Leap (Leap Prolific), Mealy, Purple Straw, Red Cross, Rocky Mountain, and "Salzer's Prizetaker." The highest percentage of infection, about 20 per cent, was obtained in the Red Cross variety, which is very similar to, if not identical with, the so-called "Salzer's Prizetaker," the variety so commonly infected on farms in the leaf-smut district. Many other varieties showed only a slight infection. A few varieties also proved to be free from the disease. These experiments have been conducted but one year and can not be accepted as at all conclusive.

Experiments were conducted with 30 different varieties in the greenhouse, where conditions were particularly favorable for infection. Several Australian varieties, as well as common winter and spring varieties of the United States, were used. The following varieties gave the indicated percentages of plants infected: (1) Highly susceptible—Bobs, 95.3; Cowra, 92.6; Defiance, 88.3; Early



Baart, 35.5; Fultz, 47.5; Hard Federation, 72.5; Federation, 90.9; Red Cross, 85.4; "Salzer's Prizetaker," 75.7. (2) Slightly susceptible—Bunyip, 2; Little Club, 2; Marquis, 7.8; Sonora, 1.9; White Australian, 4.1; Kanred, 5.4; Mealy, 2.2. (3) Free from smut—Cedar, Comeback, Early Defiance, Florence, Galgalos, Fulcaster, Poole, Red Rock, and Red May.

*Program for control and eradication.*—Plans for the prevention of its spread beyond the quarantined area and for the final eradication of leaf smut have been developed in cooperation with the Illinois State Department of Agriculture and the Illinois Agricultural Experiment Station. The plans agreed upon to accomplish these two purposes are:

(1) Thoroughly treat all grain with formaldehyde as it comes from the separator. This treatment results in making the grain worthless for seeding purposes, but does not materially affect its milling qualities.

(2) Burn all straw in the quarantined area as soon as possible after thrashing.

(3) Sow no wheat on infested fields and, so far as possible, sow no wheat on land which grew wheat this year. The infected stalks wither before the wheat ripens. As a result, large numbers of them fall out of the sheaves in harvesting and hauling, so that a considerable quantity of infested material is left on the land.

(4) Obtain seed from localities known to be free from leaf smut.

(5) Treat all seed by the copper-sulphate, or bluestone, method (dipping the grain in a bluestone solution of 1 pound to 5 gallons of water, and then in a solution of lime, 1 pound to 10 gallons). After this treatment the seed remains coated with the bluestone and lime, and this coating protects it to a large extent from infection by spores possibly present in the soil.

(6) Grow varieties that are highly resistant to leaf smut, so far as known.

#### POTATO WART.

The potato-wart investigations, conducted cooperatively by this bureau and the Pennsylvania Agricultural Experiment Station, yielded important and encouraging results during the past year. Tests of a large number of commercial American varieties of potatoes, 29 English varieties, and a number of promising new seedlings in wart-infested gardens showed 10 of the more or less extensively grown American varieties, including Irish Cobbler, Green Mountain, Sutton's Flourball, Early Petoskey, Ehnola, Extra Early Sunlight, Spaulding No. 4, Green Mountain Jr., Round Pink Eye, and Keeper, to be immune to the disease. All the English varieties and 7 of the new seedlings also proved to be immune. Of the English varieties, only 7 gave good yields, and only 1 gave a yield that compared favorably with that of the commercial American varieties. Soil-sterilization experiments showed that it is possible to kill the wart fungus by exposure to live steam under an inverted pan for 85 minutes with a pressure of 90 pounds. The indications are that a combination of formaldehyde and steam will be more effective than either treatment alone. These preliminary experiments indicate that there is much hope of eradicating the disease, at least in all the outlying infestations where one or only a few gardens are found in-

fested. Both the immunity and soil-sterilization tests are being continued this season.

#### ONION DISEASES.

The completion of a series of experiments to determine the most effective and economical rate of application of formaldehyde for the control of onion smut is one of the accomplishments of the year. These experiments have shown that 200 gallons of formaldehyde solution per acre will give the most satisfactory results and that there is no advantage in using a stronger solution than 1:128 (1 pint of formaldehyde to 16 gallons of water). Where there is serious objection to using this amount of liquid because of the difficulty of application the quantity may be reduced to 120 to 150 gallons, but in this case a stronger solution (2 pints of formaldehyde to 16 gallons of water) should be used. Raising the strength of the solution beyond this point entails danger of reduction of the stand, due to seedling injury. Experiments on a small scale have indicated that the artificial curing of onion sets is effective in controlling onion neck-rot. A study of the nature of resistance in the onion to the disease known as "smudge," which develops very readily on white varieties but to only a very slight extent on the colored sorts, has shown that this resistance is associated with the presence of the coloring matter in the outer scales. Further knowledge of the method and time of infection by this fungus and the injury resulting from its attacks has been gained.

#### PEA ROOT-ROT.

The widespread occurrence of pea root-rot and the heavy losses caused by this disease, particularly in the principal pea-canning sections in Maryland, Delaware, New Jersey, Wisconsin, Michigan, Indiana, and Ohio, led to recent active investigations of this trouble, which have shown that the losses may be greatly reduced by the rotation of crops. It has been found that the disease lives in the soil and increases rapidly in severity when peas are grown for several years in succession on the same land, as is the practice in many commercial pea-growing sections. It is distributed by the custom which has grown up in some places of transferring soil from old fields to new ones in order to carry the bacterial nodule organism from one field to another. Pea growers have been advised to keep a careful watch of their fields, especially in the old pea-growing sections, to discover the first signs of the disease and to begin rotation before extensive damage has been done. After a four-year rotation peas can again be grown, except in the Middle West, where a longer rotation has not always been successful. Progress is being made in the breeding of varieties of peas resistant to root-rot, but some time must elapse before these are ready for commercial use.

#### SWEET-POTATO DISEASES.

Considerable progress has been made during the year in the study of the physiology of the fungi which produce the decay of sweet potatoes in storage; also of the changes produced in the potato as a result of decay. These studies will lead to a better understanding of the factors involved in the susceptibility or resistance of sweet potatoes to decay, which, in turn, will suggest methods for their control.

A study of the ability of the sweet potato to form a protective covering over wounds and the factors that influence this healing process has been made. The effectiveness of the healed surface in preventing infection has been investigated and is being given further study. An improved method for the disinfection of sweet potatoes for bedding has been worked out. Heretofore, in the absence of sufficient experimental data, it has been recommended that the mercuric-chlorid solution be discarded after 3 or 4 bushels of potatoes have been treated. It is now known that by adding two-fifths to one-half ounce of the chemical after each 10 bushels have been treated, 50 bushels may be treated before it is necessary to discard the solution. A considerable saving in time and money is thus made possible for the grower.

#### CLOVER NEMATODE.

Investigations have been inaugurated during the past year of the nematode (*Tylenchus dipsaci*), which has become a serious pest of the clover crop in the Pacific Northwest. This nematode has been found to be responsible for extensive damage in the large seed-growing areas of red clover in Idaho and other Northwestern States, and there is danger that it may be carried to the important red-clover growing sections of the Central and Eastern States, to which hundreds of carloads of clover seed are shipped annually from the infested localities in the West. It has been definitely proved that the disease can be carried on the seed and that infection of the plant can occur by this means. This nematode also attacks many other plants, to some of which it causes serious injury. The investigations of the trouble are conducted in cooperation with the Idaho Agricultural Experiment Station, with field headquarters at Jerome, Idaho. They include studies of the symptoms, methods of infection, distribution, and methods of control. A preliminary survey has been made in Idaho, and a successful method of seed treatment has been found.

#### CASTOR-BEAN DISEASES.

Investigations of castor-bean diseases, which were undertaken in 1918 at the request of the War Department, were brought to completion within the past year. Major attention was given to the gray mold, or spike blight, which was found to be the cause of serious losses in the castor-bean plantings, comprising 100,000 acres or more, in the Southern States. The life history of the fungus causing this disease, which was found to be a hitherto undescribed species of *Botrytis*, was completely worked out, including the discovery of its perfect stage. Observations were made on the effect of temperature and moisture on the development of the disease in the field, and an extensive series of control experiments was carried out and practical recommendations given to the growers. It was determined definitely that the disease originated in seed imported from Bombay, India. The wilt disease of castor bean, also found to be destructive in Florida, was studied, its cause determined, and a number of field experiments looking toward the relationship of different conditions of the soil to the disease were carried out.



## INSTRUCTION OF FOOD-PRODUCTS INSPECTORS AND INVESTIGATIONS OF DISEASES OF MARKET VEGETABLES.

Cooperation has been continued with the Bureau of Markets in the training of their food-products inspectors to recognize and interpret vegetable diseases found in transit and in market. At training schools conducted at New York and Chicago about 20 new men were instructed during the year, some of whom are still in the service of the department, while others have entered State, corporation, or private business, into which they carry their pathological training and can thus act as a leavening influence for better production and distribution of farm crops. This work has been followed by visits to the various market headquarters and assistance given there in the practical application of their knowledge. Requests from railroad claim agents, shippers, storage men, and others for information concerning the disease problems connected with the production, handling, and storage of vegetables became so numerous that the preparation of a series of leaflets containing all the available information concerning the origin and spread of vegetable diseases was begun. An important feature of the work has been the making of observational trips to the producing centers, where first-hand information has been secured bearing on the development of diseases in transit and in market. These inspection trips have brought to light many new problems that need to be solved, as well as information concerning the problems already under investigation. Our pathologists have also responded to calls from the city health boards for assistance in the training of their food inspectors. Progress has been made in the study of carrot storage rots, a rot of cucumbers, and a rot of cantaloupes and in a monographic study of the genus *Rhizopus*, species of which are associated with soft rots of many vegetables. Additional data have been accumulated on the occurrence, distribution, and causes of diseases of market vegetables in California, as well as the factors governing the development of these diseases, particular attention having been given to tomato, lettuce, cabbage, and cauliflower diseases.

## CONTROL OF THE WHITE-PINE BLISTER RUST.

White-pine blister rust was first found attacking native pines in North America during the fall of 1915 in the States of Massachusetts and New Hampshire. General scouting in 1916 showed that the disease was widespread in New England and northeastern New York. Spot infections were discovered in Minnesota and Wisconsin, and a few other States had one or more infected nurseries. This wide distribution caused the Federal Government to establish immediately domestic quarantines to protect the five-needled pine forests of the far West, and many States also enacted protective quarantine laws and regulations. At this time the general eradication of *Ribes* (currants and gooseberries) was first tried as a practical method of control in two local areas in Massachusetts and one in New Hampshire.

Further scouting was carried on in the five-needled pine regions of the United States in 1917, and local demonstration control areas

were established in the New England States and New York. Efforts were made to eradicate the spot infections in Wisconsin and Minnesota and to rid infected nurseries of the disease. At the same time, extensive scouting was conducted to determine the exact conditions in these States. This work was continued in 1918, but on account of the war and difficulties incident thereto it was reduced to a minimum.

Scouting in 1919 showed that the disease was present in 9 counties in Wisconsin and 14 counties in Minnesota either on pine or Ribes or on both hosts. The attempt to exterminate the disease in these States was immediately given up and the work placed on a local control basis, as in the New England States and New York. With the exception of one diseased planted pine in Michigan and one infected patch of black currants in New Jersey, no sign of the blister rust was found in 1919 outside of the generally infected States of New England, New York, Wisconsin, and Minnesota.

#### COOPERATION IN BLISTER-RUST CONTROL.

Formal or informal cooperation has been established with all States except Florida, Alabama, Mississippi, and Louisiana, where there are no five-needled pine interests. In the New England States, New York, Pennsylvania, Wisconsin, and Minnesota, control work is placed on a dollar-for-dollar basis, whereby one dollar is spent from Federal funds for each dollar spent by the State and cooperating towns, associations, and individuals. In all cases wild and cultivated Ribes are eradicated in cooperation with and under the legal authority of the States concerned, the Bureau of Plant Industry only assuming responsibility for locating the disease and for securing the greatest possible efficiency in the cooperative expenditures. Systematic scouting for diseased pines and Ribes is being conducted outside the region of general infection, wherever there is a possibility that spot infections of the blister rust may exist. If necessary, the eradication of these secondary infections is attempted by the removal of all pines or Ribes, or both, under State authority. Nursery shipments of five-needled pines or Ribes known to be or suspected of being infected or which are shipped in violation of Federal quarantines are traced and reported to the State authorities for action. Since the States south of Pennsylvania and west to the Great Plains have been quite thoroughly scouted in previous years, work has been reduced to the minimum in these States, and special emphasis is being given to scouting in the Rocky Mountain and Pacific Coast States.

#### RATE OF PINE INFECTION.

The general distribution of the blister rust on Ribes over a number of years is causing severe damage to white-pine trees in many localities. Infected pine areas vary in size from a few pine trees within 100 feet of a single infected currant or gooseberry bush to over 50 per cent of the pines within a radius of one-half mile from plantations of diseased cultivated bushes. Strip surveys in the town of Littleton, N. H., show that 26.4 per cent of the native pines on an area of 72 square miles are infected with blister rust. Wild gooseberry bushes are responsible for this infection, the cultivated bushes being negligible. The oldest pine infection found on this area occurred in 1906,

and the wild gooseberries averaged 30 bushes per acre. This area is located 20 miles from a planting of infected pines imported about 1900. Apparently it required six years for the disease to spread 20 miles from this original center of infection, and another six years before much increase in infection took place in the secondary center at Littleton. The increase in pine infection since 1914 has been very rapid. On a rod-wide strip 67 miles long run from Lisbon to Woodsville and Piermont, N. H., and from Wells River to Ryegate, Vt., 9.9 per cent of the pines were found infected. Another rod-wide strip approximately 22 miles long was run in the vicinity of Lewis and Deerhead, N. Y., and showed that 10.9 per cent of the pines were diseased. From this evidence it is plain that general pine infection is taking place quite rapidly.

#### DAMAGE TO PINE.

Pine infection starts on the needles or small twigs and works back toward the trunk of the tree. It is usually three years, frequently four years, before a blister-rust canker can be recognized without microscopic determination. After the characteristic swelling and discoloration of the bark appear the mycelium advances along the branch to the main stem of the tree at the average rate of about 3 inches a year. Thus, the greater the distance from the trunk at which infection occurs or the larger the trunk, the longer is the time required to kill the top of the tree.

Pine seedlings 3 or 4 years old appear to be killed within four years after infection. More time is required for the fungus to grow back and girdle larger trees at a vital point on the trunk unless, as quite often happens, a small branch close to the trunk becomes infected or the disease attacks the younger portion of the main stem near the tip of the tree. Judging by the results in numerous areas of heavily infected native pine, trees 5 to 10 feet high when infected are killed, or at least commercially destroyed, in from 5 to 10 years after infection. Trees 10 to 20 feet high frequently have the lower part of the stem girdled in 8 to 10 years after infection, although 15 years frequently elapse before this occurs. Trees over 20 feet high may suffer seriously in 12 to 15 years, depending on whether the disease attacks the tips of long branches at a distance from the trunk or a small branch close to the trunk, and also on the number of branches infected. Occasionally trees of any size may be killed in a comparatively few years by having a very large number of small twigs infected over the entire crown. Thus, a tree 40 feet high was found to have 260 separate twig infections on a single main branch, and the entire tree was estimated to have 36,000 separate infections on it. These infections took place in 1914 and 1915, and the tree is now rapidly dying. Infection of this character takes place only in close proximity to large and heavily infected Ribes bushes.

#### RIBES ERADICATION.

In the New England States, New York, Minnesota, and Wisconsin the work is aimed almost entirely toward perfecting inexpensive and effective methods of destroying wild currant and gooseberry bushes; to practical demonstrations of these methods on local control



areas; to the encouragement of effective local eradication of currants and gooseberries in cooperation with towns, associations, and individuals; and to educate pine owners to a realization that wild *Ribes* exist, that the blister rust attacks white pine only after a period of growth on the wild or cultivated bushes of this genus, and that they must destroy currant and gooseberry bushes to prevent serious damage to the pine trees.

The interest of the public in safeguarding the white pine is shown by the fact that in 1919 the State forestry department of New Hampshire destroyed 21,171 cultivated currant bushes belonging to 1,023 owners, and only 3 requested compensation from the State. During the year the interest of local cooperating agencies has been very encouraging. This is well illustrated in New Hampshire, where 53 towns voted appropriations for cooperative control work, totaling \$8,514, and individuals and associations subscribed \$2,053 additional. Local agencies in cooperating States appropriated about \$25,000 for the protection of their pines by the eradication of currants and gooseberries, and the outlook for further cooperation of this sort is favorable.

Experience thus far gained on demonstration and local control areas has definitely proved that under normal conditions at least 95 per cent of the wild currant and gooseberry bushes on a given area can be permanently removed at a cost ranging from 5 cents to \$1.50 per acre. The cost of eradicating 4,574,293 currant and gooseberry bushes in the Northeastern States in 1919, on 252,114 acres, averaged 42 cents per acre for labor, or 54 cents including supervision. In 1918 the average cost, including supervision, was 66 cents per acre. The average labor cost for the New England States was reduced from 44 cents per acre in 1918 to 24 cents per acre in 1919. This marked reduction in the cost per acre was accomplished by improved methods of locating and uprooting wild currant and gooseberry bushes. It is expected that a further reduction in cost will be effected from the practical application of the results of an ecological study of *Ribes*, which is now in progress. A method of killing *Ribes* with inexpensive chemicals is also being developed.

Wild currants and gooseberries do not reappear rapidly in an area that has been worked by an efficient crew. Thorough checking on 2,485 acres in eight separate tracts previously gone over by eradication crews showed that on an average acre 62 bushes, or 95.5 per cent, were destroyed in the first working and 3 bushes in the second working. Of the latter, 2 bushes were missed in the first working and 1 bush developed from seeds or sprouts. Bushes missed by the crews usually are small plants growing in underbrush. Such plants have less leaf surface than the average plant; therefore the total percentage of protection to the pines is considerably greater than the total percentage of currant and gooseberry bushes destroyed.

In New York State, where 87 per cent of the bushes were removed in the first working of the area, it was found by actual counting of the leaves that 97 per cent of the leaf surface was destroyed. The leaves of 2,194 wild gooseberry bushes were counted in this test. In the first working of the area bushes bearing 94,429 leaves were destroyed. In three subsequent workings of the area only 3,094 leaves were found. More than 1,000 separate checks were made to determine the efficiency of the crews in eradicating wild *Ribes*. The average of

all these checks gave an efficiency in excess of 96 per cent. The eradication of *Ribes* is directed by State cooperators, but Federal inspectors are employed constantly to check the efficiency of the work. The Federal office also keeps a careful statistical record of work performed in each State, which is of value in further perfecting methods and reducing costs.

#### BLISTER RUST IN THE ROCKY MOUNTAIN AND PACIFIC COAST STATES.

The work in the western United States has been (1) locating and inspecting every blister-rust host that is known to have entered this territory from a region where the disease was present; (2) searching for violations of the Federal quarantine against shipping five-leaved pines and currant or gooseberry plants west of the Great Plains; and (3) a general examination of wild and cultivated *Ribes* and native five-leaved pines for the disease.

During the past three seasons about 7,000 planted white pines and over 200,000 cultivated gooseberry and currant bushes shipped into the far West prior to the establishment of the Federal quarantine have been located and inspected. Limited general scouting for the disease has been done in each Western State.

The white-pine blister rust (*Cronartium ribicola*) has not been found on either *Ribes* or pines in the Rocky Mountain and Pacific coast regions. A *Cronartium* found on *Ribes* in Utah, Colorado, Nevada, California, Arizona, and New Mexico has been identified as *C. occidentale*, the alternate stage of a *Peridermium* occurring on the piñon pines. This rust has never been found to attack white pines, but in many places neighboring piñon pines a few feet from them have been heavily infected for many years. Examinations of numerous white-pine plantations in Europe made recently by Mr. W. S. Moir, of this bureau, show that *Pinus lambertiana*, *P. monticola*, and *P. flexilis*, all natives of our western regions, are as readily infected and as severely injured by white-pine blister rust as *Pinus strobus*.

If the white-pine blister rust is introduced into the West, enormous losses will result, both in private holdings and in the National Forests. Due to the fact that much of the western pine is not accessible to market, the destruction would be severe in mature stands, and reproduction of five-leaved pines would be entirely prevented over most of the western white-pine areas because of the abundance and general distribution of wild *Ribes*. Sixty-five species of wild *Ribes* are indigenous to western North America. Out of this large number can be found species adapted to nearly every site and condition occurring in these regions. The constant occurrence of these secondary hosts would afford unbroken chains for the dissemination of the white-pine blister rust. The blister rust was introduced from Europe into the eastern United States only about 20 years ago. Its rapid progress in that time leaves no doubt as to what it will do in the far West if it is permitted to become established there.

#### NEMATODE INVESTIGATIONS.

##### PREDATORY NEMAS.

Attention is being given to the subject of predatory nemas and their possible utilization. Initial attempts are being made, some of them successful, to introduce and rear some of these useful species.

It is becoming more and more clear that the gall nema is one of the worst pests known to American agriculture and that any relief from the losses due to its attacks on the roots of crops would be a very great boon. Additional investigations have made it certain that this organism, like most others, has its enemies; among them are certain mononchs and other predatory nemas. Further study of the subject makes it additionally probable that there are regions suitable to the occurrence and growth of this nema in which it is not regarded as a serious pest. It is strongly recommended that examination be made of soils in such places in order to determine what are the factors that hold the pest in check.

The explorers and other officers of the Office of Foreign Seed and Plant Introduction have noted that in certain foreign countries the chayote plant is often more thrifty than it appears to be when introduced into this country. When introduced here it is found to be very susceptible to the attacks of the root-gall nema, *Heterodera radiculicola*. This has given rise to speculation as to whether predatory nemas known to exist in foreign soils may be a factor in the case. In consequence, experiments in the introduction of the foreign predatory species are being undertaken.

#### NEMAS IMPORTED FROM FOREIGN COUNTRIES ON THE ROOTS OF PLANTS.

Under this broad heading a number of investigations have been undertaken during the year, the general results of which confirm the growing belief that the indiscriminate importation of foreign plants has been the source of enormous losses to American agriculture, owing to the introduction of pests and diseases.

It is impossible in this place to go into details, but it may be said, in brief, that in no case where a small portion of soil removed from the roots of imported plants has been examined for the presence of nemas has the result been negative. In practically all cases nemas have been discovered, as a rule in large numbers and in great variety. As many as 30 different species of nemas have been taken from a few grams of soil removed from the roots of what would be called "plants imported free of soil." The portion of the soil that most closely adheres to the roots is the most densely populated with nemas. Where the number of species is large, a great variety of biological relationships exists. Along with the injurious species beneficial species are found, and others whose economic relationships are not yet understood.

The following important facts may now, however, be considered as comparatively well established: The importation of injurious parasitic species of nemas is more likely than the importation of beneficial species. This is because the parasitic species are found within the tissues of the plants, while the beneficial species—that is, the predatory nemas—are not found in these situations. From this it follows that when the roots of plants undergo the so-called "cleaning process" preparatory to shipment, the predatory nemas are more likely to be removed than the injurious ones.

Of course, these facts with regard to the possible introduction of diseases caused by nemas represent only a single phase of a much broader problem, which includes the introduction in the same way of



diseases caused by fungi, microbes, and insects. The matter is one of much greater importance than is even yet commonly supposed, and the establishment of definite facts connected with the problem is highly desirable, in order that laws, regulations, and other remedies may be devised, amended, and applied.

During the course of these investigations several exceedingly serious diseases caused by nemas have been detected when about to be imported into this country. The matter is therefore not one of theory but of conditions definitely known to exist.

#### FRUIT-DISEASE INVESTIGATIONS.

##### FRUIT DISEASES.

Apple scab, apple leaf-spot, cherry leaf-blight, and many other fungous diseases of deciduous orchards in the eastern half of the United States were very much less severe in the spring of 1920 than the previous year, mainly on account of favorable weather, a rather dry and sunny April and May.

Pear-blight over a large part of the country both east and west, but particularly over the eastern half of the United States, showed a great falling off in severity during the spring of 1920. It was less serious than normal in most sections during 1919, but the great outbreak which began in 1914 gradually declined until there is much less trouble than normal from this disease. It still has caused serious destruction in certain localities.

The form known as collar blight was unusually severe in the summer of 1919 in the Pacific Northwest, and research and service work was carried out in that section. Serious losses have occurred from collar blight in apple orchards, particularly on the Grimes and Esopus. Assistance was rendered in diagnosing and eradicating the disease. Advice has previously been given in planting new orchards to circumvent this disease by planting resistant varieties and then top-working. This can be done in the nursery by budding 2 or 3 feet above the ground, or, still better, it can be done in the orchard by top-working six or more branches after the trees have grown two to four years. Immune or resistant varieties have little or no trouble from collar blight, and experience is gradually accumulating on top-worked Grimes in the East showing the success of this plan.

To solve the collar-blight problem of the trees of these susceptible varieties already growing in the orchard a new method has been devised and proposed by which bridge grafting is utilized and the bark of the susceptible sort removed and replaced by scions of the resistant sorts. The susceptible collars of these trees, therefore, will be worked over until a result equivalent to the resistant stocks is obtained. This method will be tested next spring.

Apple cedar rust in the eastern United States continues to be an important problem. The disease was unusually severe last season and therefore renewed attention was given during the fall and winter to the removal of cedar trees, which are dangerous in the vicinity of orchards when this fungus is present. Last year's experience showed that 1 mile was not sufficient where abundant cedars occur, a greater distance for cedar removal being required. This season, in common with other spring fungous diseases, cedar rust was much less abundant than it has been for several years past.

Field experiments with pecan rosette have continued to demand most of the time of the pecan-disease experts. Some interesting and favorable results have been obtained in the control of this disease by the application of humus-forming organic matter. Each year of these field experiments marks a step in advance in the control of this disease. Spraying and dusting experiments for pecan scab have been continued, and favorable results in disease control were secured last fall and are reported for this season.

## CITRUS SCAB.

The spraying experiments for citrus-scab control have shown the marked superiority of a combined spray of Bordeaux mixture and oil emulsion. This combination prevents the increase of scale insects that usually follows the use of Bordeaux mixture in citrus groves, does not lessen appreciably the fungicidal efficiency of the Bordeaux mixture, and reduces the number of spraying operations required in the routine control of fungi and insects in the grove. The results of studies of the life history of the causal organism and the conditions influencing infection are almost ready for publication.

## MELANOSE AND STEM-END ROT.

The stem-end manifestation of *Phomopsis citri* attack has been unusually severe during 1920, although less than in 1919. Satisfactory progress has been made in the study of the relationships of the fungus to each trouble, contributing factors in infection, etc. For the first time promising results have been obtained in the control of melanose by spraying, and the success seems fundamentally due to the ability to use Bordeaux mixture freely in Florida citrus groves by the admixture of oil emulsion.

## CITRUS TEAR-STAIN.

Further evidence confirms the conclusion that tear-stain of citrus fruits prevalent in Florida and commonly ascribed to *Colletotrichum gloeosporioides* is not caused by any fungus, but is most probably a type of rust-mite injury. The entire practicability of controlling it by ordinary methods of rust-mite treatment has been determined. A final report on this project has been prepared for publication.

## WITHER-TIP OF LIME.

Life-history studies of the causal organism of the wither-tip of limes have been continued, and the attempt is being made through selection and breeding to develop a resistant lime of the general West Indies type.

## CRANBERRY DISEASES.

Studies have been continued of the various methods of harvesting and handling cranberries and on the keeping and carrying quality of the fruit. The practice of raking fruit from the water, as is frequently done in Wisconsin, may or may not be profitable, depending upon the conditions under which the fruit is grown, the variety, and the diseases present, as well as upon conditions for rapid

drying. The ventilated box as a container for cranberries has been found to be much more satisfactory for preserving the fruit than the barrel, and it is being largely substituted at present for barrels. Spraying is being more generally practiced on the Pacific coast, where certain fungous diseases are causes of serious loss. Bordeaux mixture gives promise of being a practicable preventive of red leaf-spot, end-rot, and tip-blight, which are common in that region.

#### SCAB OF APPLES AND PEARS IN THE PACIFIC NORTHWEST.

The very humid conditions that prevail in the humid sections of the northern Pacific coast have resulted in severe losses from apple scab. Investigations have shown that the disease can be held entirely in check by thorough spraying.

#### SCALD OF APPLES.

The ventilated barrel has been found extremely important in securing proper aeration in storage. Throwing open the windows of the storage room and the operation of fans to secure better ventilation have been found of value, but no method of air renewal has been completely successful. Oil wrappers have entirely controlled the disease under all storage conditions tested. At the suggestion of this bureau the Bureau of Chemistry has made a study of the gases given off by the apples and has made its report in the July number of the *Journal of the American Chemical Society*. The report states that while various esters are given off by the apples, acetaldehyde is also produced and may be the most important factor in the production of apple scald. Further experiments are being made with special reference to the more complete control of the disease in barreled apples.

#### BROWN-ROT OF PRUNES AND CHERRIES IN THE PACIFIC NORTHWEST.

It has been found that the brown-rot of prunes and cherries can be completely held in check by spraying. Also that the sprayed fruit stands up far better in shipment than the unsprayed. The more alkaline spray materials have not been found satisfactory, on account of the dwarfing effect produced on the cherries.

Similar studies are in progress on the peach-rot fungi. Shipments of peaches and cherries have also been made under various transportation conditions. Special study has also been made of the relation of Jonathan spot, scald, and other skin defects to rot infection.

#### DEVELOPMENT OF ORCHARD-SPRAYING METHODS.

Comparative tests of dusting and spraying methods were continued in both peach and apple orchards. In the case of the peach the tests were particularly severe, and neither spray nor dust gave as good control of brown-rot as was expected. The dust was about as efficient as the spray. In the case of the apple, as in previous years, scab, black-rot, leaf-spot blotch, sooty blotch, and bitter rot were not controlled by dusting. To the list of diseases almost entirely prevented by spraying but not controlled by dusting was added the New Hampshire fruit-spot, which was especially destructive in the Ozarks, where our experiments were carried on.



### CITRUS-CANKER ERADICATION.

As a result of the vigorous eradication campaign conducted by the Gulf States in cooperation with this bureau, citrus canker, a bacterial disease of citrus trees, has been practically eliminated from the greater portion of this region. Alabama, Mississippi, and Florida are free from any general infection, but it is probable that scattered cases will be found in them for one or more years, and scouting to locate and remove such cases promptly must be continued. Louisiana apparently has eradicated canker from the commercial producing area, but many scattered infected trees are being found in isolated places. Texas has practically discontinued eradication work, in compliance with a recent decision of the supreme court of that State.

### FOREST PATHOLOGY.

#### PATHOLOGICAL PROBLEMS IN WOOD CONSERVATION.

As special problems under the above rather broad heading, studies have been made on the decays and discolorations of woods used in the airplane industry, from the standpoint of the inspector, and studies have been continued on the effect of incipient decay on the strength of airplane timber. That there is a great difference in the effect of different fungi on the strength of the wood has been conclusively proved. Preliminary studies have been begun on the effect of rot on woods used in the manufacture of chair parts, automobile parts, etc. Experiments on the control of sap-stain, sap-rot, and mold in vehicle stock have been concluded, and a report on the experiments has been practically completed.

#### FOREST-TREE DISEASES.

The work under this head may be divided into two sections: (1) Work on the nursery diseases and (2) work on general forest-tree diseases.

Considerable study has been given during the past year to the relation of fire to the general problems of forest pathology. Fire injury has been found to be responsible for the greater part of all fungous infections, because fire causes wounds through which the fungi gain entrance to the tree. During the statistical studies of fungous infection in felled trees very interesting data on the previous history of fire injury in the great forest regions of the West have been gathered.

## REPORT OF THE FORESTER.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
FOREST SERVICE,

*Washington, D. C., October 4, 1920.*

SIR: I have the honor to transmit herewith a report of the work in the Forest Service for the fiscal year ended June 30, 1920.

Respectfully,

WILLIAM B. GREELEY,  
*Forester.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### A NATIONAL FORESTRY POLICY.

In the report of the Forester for the fiscal year 1919 my predecessor, Col. Henry S. Graves, set forth the urgency of a national forestry policy. During the major part of the fiscal year covered by this report the movement gathered headway under his leadership. Since his resignation, on April 15, 1920, the movement has continued along the lines laid down by him, and the program which he formulated has been further developed.

This program is based on the conviction that the problem of halting forest devastation is fundamentally a national, not a local, problem, and must be faced and handled as such. At the same time it is felt that the speediest, surest, and most equitable action can be secured through dependence on the police powers of the States for the enforcement of such reasonable requirements as should be made of private owners and on the State governments for providing organized protection of private lands against fire. Because the problem itself is essentially national—that is, one affecting the public welfare of the entire country and requiring to be attacked as a whole, not piecemeal—both Federal leadership and a large measure of Federal aid are obligatory. It should be obligatory upon private owners to apply the safeguards necessary to prevent devastation. There is a practical unanimity of agreement that the first and most essential step is nation-wide protection from forest fires, applicable to all classes of forest land and borne jointly by the landowner and the public.

When the movement was inaugurated the chief effort was directed toward laying the need for action before those having first-hand knowledge of forest conditions and most directly concerned in forest industries. Conferences were held in various parts of the country with representatives of the lumber, paper, and other forest-using industries, and with State officers having to do with forest matters. The widest discussion of the situation and the precise measures

needed was invited. Interest in the subject developed rapidly. Organizations of the various industries dependent on forests for raw material began to canvass the situation, in many cases to appoint forestry committees and to formulate programs of their own. It was chiefly along these lines that the movement advanced during the year, though there was not lacking evidence of a decided awakening of interest on the part of the public generally. To this the acute shortage and skyrocketing prices of lumber and newsprint, which marked the year, undoubtedly contributed.

The crucial character of the forest situation of the country was made more clear than ever before by the results of a study made in the latter part of the year by the Forest Service, in response to Senate resolution 311. The results of this study were embodied in a report entitled "Timber Depletion, Lumber Prices, Lumber Exports, and Concentration of Timber Ownership," and were submitted to the Senate on June 1. It was found that over two-thirds of the original forests of the United States have been culled, cut over, or burnt, and three-fifths of their merchantable timber is gone. The country is taking about 26,000,000,000 cubic feet of wood annually from its forests and is growing but 6,000,000,000 feet. We are cutting timber of every class, even trees too small for the sawmill, much faster than they are being replaced in our forests.

There are still large quantities of timber in the United States, but they are not in the right place. Sixty-one per cent of what is left lies west of the Great Plains, far from the bulk of our population, agriculture, and manufactures. The exhaustion of one forested region after another in the Eastern States has been reflected in rising transportation costs, in shortages of supply resulting from the overloading of transport facilities, and in a narrowing field of competition between regional groups of sawmills. The distance between the average sawmill and the average home builder is steadily increasing; and we shall soon be dependent for the bulk of our construction lumber upon the forests of the Pacific coast. These conditions have had a vital bearing upon the high cost of lumber, which, during the year, reached a prohibitive figure for many uses and checked the building of homes which is so urgently needed.

We have used up our forests without growing new ones. At the bottom of the whole problem is idle forest land. The United States contains 326,000,000 acres of cut-over or denuded forests containing no saw timber; 81,000,000 acres of this amount have been completely devastated by forest fires and methods of cutting which destroy or prevent new timber growth. The area of idle or largely idle land is being increased by from 3,000,000 to 4,000,000 acres annually as the cutting and burning of forests continue. We are short of growing forests.

To stop the devastation of our remaining forests and put our idle forest lands at work the first step must be the enactment of a Federal law whose two chief provisions are (1) a comprehensive plan of Federal cooperation with the States in fire prevention and the development of forestry practice, and (2) extension of the National Forests through purchases along the line initiated by the Weeks Act, through the inclusion of other timberlands now in Federal ownership, and through exchange.



## PERSONNEL.

Since the last report the inadequacy of the salaries paid to employees of the Forest Service led to such discouragement and so many resignations that complete demoralization of the Service was threatened. The small increases granted by Congress to a part of the statutory roll, effective July 1, 1920, exerted some steadying influence. The Forest Service has exhausted every means at its disposal to adjust salaries to present living costs and the responsible duties demanded of its employees. The employment situation has been improved, but it can not be met effectively without radical increases in the rates of compensation fixed by statute.

As experienced men leave and green men take their places, there is a gradual lowering in the effectiveness of fire prevention and the quality of the service given to National Forest users. Costly experience has shown that to hire fire guards at prewar rates means doing without the capable woodsmen who could be secured at such wages before the war and filling their places with unseasoned men whose lack of skill or endurance may be responsible for fire losses far greater than the cost of capable men; but enough to secure competent labor can be paid only by reducing the number of guards below the safety point. Many experienced Forest officers are holding on, notwithstanding starvation wages, because of loyalty to the Service, of a desire to stay on their chosen work, and of faith that fair salary adjustments will be made. But no organization can be carried on indefinitely by depending on such qualities in its personnel.

The Government demands of a forest supervisor, paid on an average \$2,368 per year, including the temporary war-time bonus, the honest and efficient handling of public property worth fifteen or twenty million dollars and an income-producing business often ranging from \$50,000 to \$100,000 a year. He must represent the Government in dealing with hundreds of stockmen, lumbermen, and other Forest users, whose business must be impartially and efficiently dispatched. Of the forest ranger, whose average salary with bonus is \$1,516, the public demands the efficient protection of from 100,000 to 300,000 acres of its timberland. He must be qualified to cruise and appraise timber, to supervise the construction of roads and trails, to direct a large protective organization during the dry months, to make sales of stumpage, and to deal honestly, efficiently, and courteously with the logger, the stockmen, the homesteader, the camper, and every other class of Forest user.

No commercial organization in the United States would expect such qualifications and services as those demanded of forest supervisors and rangers, the backbone of the field organization of the Forest Service, at double the salaries paid to these public employees. The real injury from low salaries is not to employees of the Government, who can take care of themselves, but to the Government itself. The loss of well-trained and efficient men means poorer protection of public property, less efficient handling of public business, and poorer service to the hundreds of thousands of people and the many industries which use the National Forests.

Contrary to the idea often expressed, efficiency in the public service equal to that under the best commercial standards is entirely possible. It has been achieved in many cases. But the Gov-

ernment must pay for it, just as the commercial organization must pay for it.

An experienced and trained personnel on the National Forests is an absolute necessity. The great opportunity for public service in the permanent and well-ordered use of these national resources will not be realized if there is a constant turnover of personnel, such as is now taking place, due to meager compensation. For the same cause it is often impossible to recruit the Service from the best men of technical training or practical experience. No organization can perform miracles; and the public Forests of the United States can not be effectively protected from fire, developed, and administered to meet the tremendous demands being made upon them without a field force whose compensation is on a par with the work demanded.

## THE NATIONAL FORESTS.

### EXPENDITURES AND RECEIPTS.

The receipts from the National Forests in the fiscal year 1920 were greater by \$435,067.42 than in the previous year, and totaled \$4,793,482.

Receipts from timber sales alone increased \$496,300.53, but receipts from grazing decreased \$129,934.07, chiefly because of reductions in the herds of many permittees, owing to the exceptional conditions in the live-stock and forage markets.

The increase in receipts from timber sales reflects the increasing demands being made on the National Forests as privately owned timber is exhausted and the forest industries move westward. With the progressive depletion of privately owned timber in many sections, the National Forests will be called upon to contribute a rapidly increasing proportion of the general timber supply. If funds are provided for the examination and sale of National Forest timber, now in demand, the receipts from timber sales may be expected to increase still more rapidly until the cut reaches the limit that must be imposed in order to maintain a continuous yield from the Forests and give stability to the industries and communities dependent upon them.

While receipts have been increasing year after year, the money appropriated has remained practically stationary. From 1915 to 1920, receipts increased 93 per cent. During the same period the total appropriation for the Forest Service increased 8 per cent, exclusive of deficiency appropriations for fire fighting. In 1920 receipts increased 10 per cent over the previous year, while the total appropriations, exclusive of deficiency items, increased 4 per cent. An equal increase for the current fiscal year may be expected unless too much new business has to be rejected on account of lack of funds and trained employees, but the appropriations for the current year were increased 3 per cent only.

Every resource of ingenuity in administration and public cooperation has been called upon, with the result that the service rendered to National Forest users and the efficiency of protection from fire have suffered to a very small extent. It has been necessary, however, to refuse new business in places, and it has not been possible to develop

properly such uses as the leasing of summer-home sites, for which there is a rapidly growing demand.

The following table shows the purposes for which the total appropriation for the Forest Service was expended:

*Expenditures of Forest Service appropriation.*

Protection and administration of the National Forests.....	\$4, 715,961
Fighting fires which could not be suppressed by regular protective force <sup>1</sup> .....	150, 000
Classification, survey, and segregation of agricultural land, and accomplishment of authorized land exchanges.....	107, 000
Planting 7,043 acres of nonproducing land, maintenance of nurseries, and experiments in tree planting.....	145, 640
Permanent improvements such as buildings, bridges, trails, telephone lines, drift fences, water developments <sup>2</sup> .....	450, 000
Estimating the amount and fixing the minimum value of timber for sale .....	50, 000
Examination of intensively used ranges with a view to increasing their productivity by more scientific management of stock and forage .....	30, 000
Investigations:	
Forest products, including Forest Products Laboratory at Madison, Wis.....	\$173, 260
Silvicultural .....	78, 728
Range and forage plant.....	35, 000
	286, 988
Recording, digesting, and disseminating the results of scientific and technical work.....	31, 280
Total.....	5, 966, 869

It should be noted that the receipts exceed by \$78,000 the cost of protection and administration on the National Forests, exclusive of emergency fire expenditures, the construction of improvements, and special development and research projects. In addition to this revenue, there is an enormous return to the public through the protection of five hundred-odd billion feet of timber for future use, the protection of the headwaters of innumerable feeders of navigation, irrigation, and hydroelectric power, and the recreational facilities made available to hundreds of thousands of our people. The monetary income from the National Forests can be expected to increase steadily. But there will always be national returns not measurable in dollars which in public benefit exceed the receipts paid into the Treasury.

These returns should be given their due weight in the policy adopted toward the development and administration of the National Forests. Their possibilities for public service can not be accomplished if the returns in dollars alone are entered into the ledger.

**THE NATIONAL FOREST PROPERTIES.**

The net area of the National Forests at the close of the fiscal year was 156,032,053 acres, as against 153,933,700 acres one year before. The corresponding gross areas were 180,299,776 acres and 174,261,393 acres. The gross area includes all land within the National Forest boundaries; the net area excludes alienated lands.

<sup>1</sup> An additional deficiency appropriation of \$2,950,000 was required for this purpose.

<sup>2</sup> Of this sum nearly half is required for the maintenance of existing improvements used in the protection and administration of the National Forests.



The apparent net increase of 2,098.353 acres includes 654,942 acres previously purchased under the act of March 1, 1911, but not given the formal status of National Forests until proclaimed as such during the past fiscal year. The actual net increase of Government Forest lands administered by the Forest Service was therefore 1,443.651 acres. It is due principally to the addition by act of Congress of about 1,000,000 acres, embraced in the Thunder Mountain region in Idaho, to the Idaho and Payette National Forests.

Special acts of Congress made small additions to five other National Forests, while by proclamation of the President 180,355 acres net were added to the Coconino and Prescott National Forests, since Federal regulation of the use of this land is necessary for the protection of important reclamation projects on the Verde River. The title to many school selections reverted to the Government during the year through selections by the States of other public lands outside the National Forests. The increase from these various causes was partially offset by seven presidential proclamations and executive orders making eliminations from individual National Forests to a total of 34,252 acres, and by eliminations due to land exchanges with the States of Idaho and South Dakota which made a further reduction of 34,543 acres.

With two exceptions—1911 and 1913—no other fiscal year since 1909 has closed with a net increase in the area of National Forest lands. The gain made last year is almost identical with the area loss of the year before. That the cutting-down process, which has resulted from careful land classification, would with the completion of that work give place in its turn to a renewed growth in the acreage of the Forests was to be expected. Most of the increase made last year was through special acts of Congress in answer to local public sentiment and evidences the stability of the reservations, the efficiency of their administration, and the value of their public service. Numerous other measures now before Congress would materially increase this acreage if enacted into law. Several of these measures have already passed the House or Senate.

Owing to the virtual exhaustion of the appropriation for the purchase of lands for National Forests in the East, little progress was made in acquiring new lands in the White Mountains and the southern Appalachians. At the close of the year 1,420,208.05 acres had been purchased in these regions. In addition, 12,094.40 acres were purchased in the Ozark Mountains in Arkansas. All purchased lands have now been formally proclaimed and organized as National Forests. There remained under process of acquisition 375,296 acres, purchase of which had been approved by the National Forest Reservation Commission. The work of completing such contract obligations is necessarily being continued. Meanwhile the personnel engaged upon this work is kept fully employed by examinations of other lands offered for purchase in anticipation of further appropriations. The original program of acquisition contemplated the purchase of about 1,000,000 acres in the White Mountains and not less than 5,000,000 acres in the southern Appalachians. Nearly one-half the proposed White Mountain area has been acquired, but slower progress has been made in the southern areas. The commission has formally recommended further appropriations to carry on the pur-

chase work within the areas already approved and in part acquired. To leave these eastern Forests in their present half-finished condition would subject them to formidable fire hazards and other difficulties of management.

The total area of alienated lands within the National Forests at the close of the year was 24,267,723 acres. Much of this land is forested and should always be used for growing timber. It is usually intermingled with timberlands belonging to the Government, and its misuse, mismanagement, or neglect jeopardizes the Government's holdings. Evidently some action should be taken to reduce the danger to our public Forests from this source, either by acquiring the private lands or by making some equitable arrangement with the owners through exchange. Numerous bills are now pending in Congress granting authority to the Department to deal with the situation on limited areas and within certain Forests. The problem, however, is found upon every Forest, and the situation can only be remedied by general legislation. It will take many years of careful, painstaking negotiation to correct the damage done through allowing the alienation of timbered lands which should have remained in public ownership. The importance and necessity of general legislation whereby our National Forests may be properly completed and adequately protected through consolidation by exchanges with private owners can not be too strongly urged.

#### PROTECTION.

The fiscal year opened with the Forest Service already in the midst of a fire season which had become serious in June and was to prove one of the severest as well as one of the most protracted ever known. It was the third successive year of severe drought in the Northwest, and the worst of the three. The fire season began so early that the customary preparations—the repair of trails and telephone lines damaged by the winter storms, the organization of the protective force in the field, and the placing of crews in the Forests on summer construction work from which they could be summoned to assist in fire suppression in their neighborhood if occasion should arise—had not been fully completed. In addition, the Forest Service was under a handicap because of the many personnel changes that had depleted its force of experienced men and necessitated much shifting about of the men left, often to posts where they were not thoroughly familiar with the locality; and was further handicapped by the great difficulty of securing capable temporary employees to serve as lookouts, patrolmen, smoke chasers, and straw bosses.

Early in June hot weather and dry winds began to create conditions of danger in the northern Rocky Mountain region after a brief spring. By the middle of the month fires began to start, and before its close it was plain that unless abnormal summer rains should relieve the drouth a long and difficult fight was ahead.

No rains came. On the contrary, throughout Montana, parts of Wyoming, northern Idaho, all of Washington and Oregon, and northern California the weather conditions were exceptionally unfavorable until early September. In northern California the dry season continued until nearly the middle of November, and in southern California until December. In Montana, northern Idaho, east-

ern Washington, and eastern Oregon the drought was of the gravest character.

An exodus of farmers from eastern Montana, driven by the ruin of their crops to seek employment as day laborers elsewhere, made it possible for the Service to recruit in midseason additional fire fighters in the regions where the fires were most severe and the difficulty in obtaining sufficient labor most embarrassing.

Throughout the central Rocky Mountain and Great Basin regions summer rains were generally sufficient to relieve a situation which in the early part of the season was seriously threatening, so that in this region the conditions for the season of 1919 were normal and without extensive fires. In the Southwest the season was exceptionally favorable, with trifling losses and small fire-fighting expenditures; the usual fall fire season did not develop at all. In Minnesota the season was normal, in Arkansas bad with 143 fires and over 25,000 acres burned over, and in the eastern Forests generally good except for brief periods during which a number of fires developed on the Pisgah and Unaka Forests.

Certain statistics regarding the fires in 1919 are given below:

*Fires on National Forests, calendar year 1919.*

Classes and causes of fires.	Number of fires.	Percentage of total.
<b>Class of fire:</b>		
Burn less than 0.25 acre.....	2,839	41.75
Burn between 0.25 acre and 10 acres.....	2,014	29.62
Burn 10 acres and over, damage under \$100.....	1,170	17.21
Burn 10 acres and over, damage \$100 to \$1,000.....	449	6.60
Burn 10 acres and over, damage over \$1,000.....	328	4.82
Total.....	6,800	100.00
<b>Causes of fires:</b>		
Railroads.....	701	10.31
Lightning.....	2,197	32.31
Incendiarism.....	339	4.99
Brush burning.....	360	5.29
Campers.....	1,466	21.56
Lumbering.....	278	4.09
Unknown.....	1,155	16.98
Miscellaneous.....	304	4.47
Total.....	6,800	100.00

The total number of fires, 6,800, was 1,227 greater than in 1918. The area of National Forest lands burned over was 2,007,034 acres, as against 694,651 in 1918; the estimated damage was \$4,919,769, as against \$688,332; and the total cost of fire fighting (exclusive of the time of Forest officers) was \$3,039,615, as against \$714,009.63.

The appropriation item for fire fighting for the fiscal year 1920 carried \$150,000, and it was necessary to draw on the funds available for general expenses of administration and protection and to seek reimbursement of these funds from Congress through a deficiency appropriation of \$2,950,000, which became available November 4, 1919, just as the general funds reached exhaustion. Had Congress not been in session, the exhaustion of funds would have had most serious consequences.

Much the largest number of fires (2,258) were in district 1 (Montana and northern Idaho). This district also had most of the fires which caused damage in excess of \$1,000 (199 out of a total of 328).



District 6 (Washington and Oregon) had 1,591 fires, and district 5 (California), 1,108. Together, these three districts had 73 per cent of all the fires.

Not quite three-fourths of the land burned over was timbered. In a number of cases the fires swept areas previously burned in 1910, destroying the reproduction which had come up on these old burns. As a rule the land which was thus burned over a second time will now have to be artificially reforested to secure a new timber growth.

The percentage of lightning fires was markedly less than in 1918, of incendiary fires practically the same, and of fires caused by campers considerably greater. Since practically 60 per cent of the fires of known causes were due to human agencies, the need of the most energetic efforts to bring home to the public the importance of care to prevent fires is self-evident. The Forest Service is earnestly seeking to lessen the number of man-caused fires in this way. Larger provision for carrying on the educational efforts which are being made along this line is needed. An increase in the appropriation to provide for this was sought last year, but was not secured. In comparison with the amounts which the Government must spend to stop the fires, if they start—to say nothing of the damage to the forests caused by the fires—the cost of the most thorough-going campaign for fire prevention would be wholly negligible. As recreational use of the Forests by the public increases and the local population and activities of all kinds on and near the Forests become greater, man-caused fires are bound to become more numerous unless educational methods can be made effective.

The very general observance of Fire Prevention Week in many of the Western States last May is believed to have had substantial results. Forest officers took an active part in bringing to public attention at that time the importance of preventing fires and the precautions which it is necessary to observe in order not to cause fires. To provide for better coordinated and supervised activities along this line and for more careful planning of methods by which public interest may be increased in both the protection and use of the Forests, a Branch of Public Relations was organized, effective May 20, 1920.

At the outset the prospects for the season of 1920 were exceptionally favorable in most of the West, though the spring fire season in the Southwest, where the principal hazard is in the spring and fall, taxed the energies of the protective force to hold the fires in check. In the northern Rocky Mountain and Pacific Coast States the winter snows melted slowly and the spring rains were abundant. In California, however, the season opened extremely hot and dry, with early June fires in exceptional numbers through the northern Sierras.

By the middle of July an acutely hazardous condition had developed in the Northwest, but the fires were held well in hand until about August 1 dry electrical storms began to start an extraordinary number of fires, chiefly in the high mountains, where they are most difficult to get at quickly. Fortunately the fall rains set in early—before the end of August—so that the acute period was relatively brief. The cost of fire fighting was increased by the high prices of supplies and the prevailing wage scale. The expenditures for fire fighting were approximately \$800,000. Since the appropriation for this purpose was \$250,000, a deficiency appropriation must again be sought. It has been necessary to go to Congress for such appropri-

ations in six out of the nine years that have passed since the fire-fighting funds were cut from \$1,150,000 for the fiscal year 1912 to \$350,000 for 1913, with subsequent further reductions. It is believed that in normal years an expenditure for fire fighting of from \$600,000 to \$800,000 must be anticipated.

#### MANAGEMENT.

##### TIMBER.

The growing shortage of timber in the Eastern States has an important bearing upon the administration of the National Forests. Many forest industries are moving westward to new fields of raw material. They are bringing to the National Forests an increasing demand for publicly owned timber. They are putting to the test, as never before, not only the efficiency of the Forest Service as business manager of 155,000,000 acres of public property, but also the basic idea of forest management, namely, controlled use with a constant renewal and perpetuation of the resource.

The economic relation of the National Forests to local communities and to particular industries also assumes an increasing measure of importance. In many instances the National Forests now stand as the principal means of livelihood for manufacturing communities and large groups of labor and as the source of support of many industrial enterprises. This development must be made stable. The sawdust piles and abandoned mill towns of forest regions in the East must not be repeated in the public forests of the West. Current use of their timber must be limited to the material which they can produce, and the economic means for the utilization of their timber crops must be developed along stable lines which will make for the interest of the greatest number in the long run.

An insufficient supply of newsprint and other papers is one of the most pressing phases of our national situation as to timber. There is but one effective remedy of the paper shortage—increased production. The forest resources of the West, particularly the National Forests, offer opportunities for the increased manufacture of paper on a scale adequate to meet all the requirements of the country. Large areas of pulp timber are available in the northern Rocky Mountains, on the west slope of the Cascade, in the Sierras, and in the National Forests of Alaska. The enormous coastal Forests of Alaska particularly, with their available water powers and opportunities for tidewater shipment, should be one of the largest and most permanent sources of paper for the entire United States. These public Forests can furnish 1,500,000 tons of paper annually for all time to come, if they are developed under effective public control and in accordance with a sound technical policy. It is indeed fortunate that, in meeting the problems of timber depletion, the Nation controls these vast Forests as public resources available for development in such ways as will best serve the public welfare. The national interests in the Forests of Alaska, as in the public Forests of the Western States, must not be lost sight of in the consideration of any questions relating to their development or administration.

There was a marked increase in the timber business on the National Forests during the year. The amount cut increased by 100,000,000 board feet, or about 14 per cent, and the amount sold by 527,000,000

board feet, or about 66 per cent. The amount cut in 1920 exceeded the amount sold in 1919, when lumbermen hesitated to buy large amounts of timber because of the high cost of building logging railroads or other means of transportation. At the close of the year the business is still increasing and in many regions is as large as can be administered efficiently by the limited force available under present appropriations.

One very gratifying extension of the timber business during the year is the progress in securing the use of pulp timber in the National Forests of Alaska. The continued shortage of paper, especially newsprint, and the enactment of water-power legislation have greatly stimulated the interest of paper manufacturers in the opportunities in southeastern Alaska. One large sale was negotiated and advertised during the year, and the contract has been signed since June 30. Construction work on the power and pulp-manufacturing plants is now in progress. Other bodies of timber were cruised at the request of responsible applicants, and further sales for the supply of large paper-making plants in southeastern Alaska appear certain. Thirty years' supply of raw material is offered under these contracts, with an equitable provision for the readjustment of stumpage prices from time to time.

Such sales not only will tend to relieve the acute paper shortage in the country but represent a most desirable form of permanent development for southeastern Alaska, where the timber is suitable for pulp and paper manufacture as well as for the manufacture of lumber. The great area of forest-bearing land, the rapid growth of timber suitable for paper making, and its accessibility to tidewater afford opportunities for at least 12 or 15 large pulp and paper mills. Under careful handling of the forests these can be supplied permanently and will support an industrial population of considerable size.

The Forest Service does not propose to repeat in Alaska the process of pulpwood depletion which has taken place under private ownership in the old paper-manufacturing regions. This new industry in the National Forests of Alaska will be restricted in size to what they can permanently support. The immediate need, however, is to secure the establishment of several plants, and toward this the Service is making every effort.

The increase in the timber business of the National Forests generally has emphasized the need, mentioned in last year's report, of determining within relatively close limits the quantities of timber which may be cut from forest units on a basis of permanent production. Good progress is being made both in blocking out definite units to be handled on a sustained-yield basis and in determining what the yield of each will be. The work is being pushed first on those Forests where the demand is heaviest, and where, as a consequence, the need for such plans of management is most acute. During the year 597,563 acres were cruised carefully and 22,372 roughly, both in order to prepare for sales and to secure an inventory on which to base plans of timber management. There is urgent need for an increase in this work, particularly on some of the Forests in the Eastern States and on the Tongass Forest in Alaska.



Details in regard to timber sales are shown in the following tables:

*Timber sold fiscal year ended June 30, 1920.*

State.	Board feet.			Value.		
	Commercial sales.	Cost sales.	Total.	Commercial sales.	Cost sales.	Total.
Alabama.....	4,000	.....	4,000	\$10	.....	\$10
Alaska.....	51,165,000	.....	51,165,000	86,853	.....	86,853
Arizona.....	29,035,000	748,000	29,783,000	65,807	\$598	66,405
Arkansas.....	13,902,000	207,000	14,109,000	63,543	154	63,697
California.....	336,452,000	9,058,000	345,510,000	856,471	4,707	861,178
Colorado.....	96,859,000	1,989,000	98,848,000	212,949	1,482	214,431
Florida.....	458,000	.....	458,000	756	.....	756
Georgia.....	8,126,000	.....	8,126,000	25,733	.....	25,733
Idaho.....	129,286,000	4,585,000	133,871,000	387,999	3,524	391,523
Michigan.....	5,516,000	5,000	5,521,000	6,139	4	6,143
Minnesota.....	30,143,000	19,000	30,162,000	59,410	14	59,424
Montana.....	67,487,000	7,335,000	74,822,000	147,812	5,781	153,593
Nevada.....	1,263,000	50,000	1,313,000	1,543	38	1,581
New Hampshire.....	2,657,000	.....	2,657,000	15,139	.....	15,139
New Mexico.....	21,256,000	1,075,000	22,331,000	57,315	662	57,977
North Carolina.....	5,829,000	.....	5,829,000	15,966	.....	15,966
Oregon.....	121,025,000	3,788,000	124,813,000	214,335	1,921	216,256
South Dakota.....	55,227,000	735,000	55,962,000	153,173	626	153,799
Tennessee.....	18,202,000	324,000	18,526,000	29,996	243	30,239
Utah.....	7,724,000	1,018,000	8,742,000	16,975	791	17,766
Virginia.....	7,327,000	35,000	7,362,000	18,900	30	18,930
Washington.....	128,800,000	628,000	129,428,000	251,903	320	252,223
West Virginia.....	52,000	.....	52,000	149	.....	149
Wyoming.....	156,431,000	867,000	157,298,000	337,260	662	337,922
Total, 1920.....	1,294,223,000	32,476,000	1,326,699,000	1,306,136	21,557	3,047,693
Total, 1919.....	772,633,000	26,267,000	798,900,000	1,809,439	19,451	1,828,890

<sup>1</sup> In addition, minor products, not convertible into board feet, were sold, value \$5,924.

<sup>2</sup> In addition, minor products, not convertible into board feet, were sold, value \$5,981.

*Timber cut under sales fiscal year ended June 30, 1920.*

State.	Board feet.			Value.		
	Commercial sales.	Cost sales.	Total.	Commercial sales.	Cost sales.	Total.
Alabama.....	4,000	.....	4,000	\$20	.....	\$20
Alaska.....	45,403,000	.....	45,403,000	80,189	.....	80,189
Arizona.....	52,789,000	565,000	53,354,000	137,019	\$459	137,478
Arkansas.....	17,981,000	268,000	18,249,000	63,691	203	63,894
California.....	143,066,000	2,336,000	145,402,000	328,453	1,248	329,701
Colorado.....	49,308,000	1,117,000	50,425,000	108,653	816	107,469
Florida.....	49,832,000	.....	49,832,000	1,932	.....	1,932
Georgia.....	2,911,000	.....	2,911,000	11,684	.....	11,684
Idaho.....	77,759,000	4,460,000	82,219,000	197,951	3,394	201,345
Michigan.....	6,649,000	5,000	6,654,000	1,349	4	1,353
Minnesota.....	13,026,000	19,000	13,045,000	38,843	14	38,857
Montana.....	54,491,000	6,172,000	60,663,000	123,965	5,008	128,973
Nevada.....	1,543,000	40,000	1,583,000	2,080	30	2,110
New Hampshire.....	3,537,000	.....	3,537,000	19,660	.....	19,660
New Mexico.....	34,606,000	726,000	35,332,000	75,653	481	76,134
North Carolina.....	8,470,000	.....	8,470,000	27,924	.....	27,924
Oregon.....	118,454,000	2,788,000	121,242,000	236,514	1,500	238,014
South Dakota.....	21,708,000	628,000	22,336,000	52,386	571	52,957
Tennessee.....	7,861,000	374,000	8,235,000	13,630	279	13,909
Utah.....	11,470,000	930,000	12,400,000	25,733	719	26,452
Virginia.....	5,329,000	26,000	5,355,000	11,874	28	11,902
Washington.....	78,415,000	1,064,000	79,479,000	115,025	536	115,564
West Virginia.....	52,000	.....	52,000	149	.....	149
Wyoming.....	33,681,000	666,000	34,347,000	80,929	510	81,439
Total, 1920.....	783,325,000	22,184,000	805,509,000	1,753,309	15,800	1,769,109
Total, 1919.....	685,172,000	19,597,000	704,769,000	1,497,702	14,670	1,512,372

<sup>1</sup> In addition, minor products not convertible into board feet were cut, value \$2,362.

<sup>2</sup> In addition, minor products not convertible into board feet were cut, value \$7,779.

*Number of timber sales, classified according to amount of sale, fiscal year ended June 30, 1920.*

State.	\$100 or under.			\$101- \$500	\$501- \$1,000	\$1,001- \$5,000	Over \$5,000	Total.
	Com- mercial.	Cost.	Total.					
Alabama.....	4		4					4
Alaska.....	355		355	4	3	13	1	376
Arizona.....	678	263	941		8	5	5	959
Arkansas.....	38	62	100	4	1	7	2	114
California.....	507	434	941	19	11	125	9	1,005
Colorado.....	632	270	902	6	3	13	10	934
Florida.....	29		29					29
Georgia.....	46		46		2	2	1	51
Idaho.....	740	1,026	1,766	21	9	18	12	1,826
Michigan.....	11	2	13	3		1		17
Minnesota.....	13	4	17	3	1	1	1	23
Montana.....	921	1,436	2,357	29	14	21	34	2,455
Nevada.....	82	5	87					87
New Hampshire.....	123		123	2			2	127
New Mexico.....	780	455	1,235	3	3	9	2	1,252
North Carolina.....	140		140	6	2	4		152
Oregon.....	300	555	855	11	3	8	6	883
South Dakota.....	462	121	583	6	9	13	9	620
Tennessee.....	96	106	202	8	2	9		221
Utah.....	407	539	946	8	1	1		956
Virginia.....	287	15	302	1	3	3	1	310
Washington.....	279	143	422	4	4	15	11	456
West Virginia.....	3		3					3
Wyoming.....	219	128	347	2	4	5	4	362
Total, 1920.....	7,152	5,564	12,716	140	83	173	110	13,222
Total, 1919.....	6,227	6,621	12,848	120	64	114	46	12,592

<sup>1</sup> Includes one cost sale.

**REFORESTATION.**—The details of planting and sowing operations are given in the following table:

*Planting and sowing on National Forests, by States, 1920.*

State.	Area planted.	Area sowed.	Total.	State.	Area planted.	Area sowed.	Total.
	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>		<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Washington.....	1,415.00		1,415.00	California.....	235.00		235.00
Idaho.....	1,288.00		1,288.00	Utah.....	95.00		95.00
Montana.....	775.00		775.00	New Mexico.....	30.00		30.00
Minnesota.....	769.00		769.00	Ala. a. ma.....		10.00	10.00
Colorado.....	760.79	2.33	763.12	Virginia.....	9.40		9.40
Nebraska.....	505.95		505.95	Arizona.....	3.00		3.00
Michigan.....	420.50		420.50	Florida.....	.20		.20
Oregon.....	412.00		412.00				
Wyoming.....		312.00	312.00	Total.....	6,718.84	324.33	7,043.17

With the decreased appropriations available for planting on the National Forests and the increased cost of labor, planting operations have been concentrated more and more in those regions where the work could be done most successfully and most cheaply. During the year the nurseries which have been maintained in New Mexico, Utah, and California were closed, and planting was discontinued in those States with the spring of 1920. The work has been continued on a somewhat reduced scale in the Pacific Northwest, in northern Idaho and western Montana, in Colorado, and in Nebraska. Further reductions in these regions are inevitable unless the appropriation is restored to at least its prewar total, since the stock in the nurseries started from seed when labor was not so

expensive has now all been planted. It is also very desirable to expand the planting on the National Forests in Michigan and Minnesota, where there are large areas of land, denuded by fire, which can be planted cheaply and effectively. The plantations already established in these States have been notably successful and are restoring to productivity land which had been completely devastated by repeated fires.

#### RANGE.

GENERAL CONDITIONS.—Unusual grazing conditions characterized the year. In the Southwest the ranges have seldom been better, but from about the latitude of Denver north the year was highly unsatisfactory to stockmen.

Practically throughout this region drought during the summer of 1919 was followed by an exceptionally severe winter, which in Colorado, Wyoming, Montana, and part of Utah was unusually prolonged. Early in April, when the supplies of feed were generally exhausted and just as the stock was being turned out on the ranges, a series of storms set in. The usual early growth of grass did not appear, and the cattle and sheep, weak and gaunt from their long winter, died by thousands in spite of the vigorous efforts made by their owners to get feed to them. Hay went to about \$40 a ton on the average, and in many instances \$50 and \$60 was paid.

In California, the prolonged period of cool spring weather during which the grass grew but little was unusually serious, and sheep suffered severely, especially during lambing time. In the face of this emergency the ranges on many Forests were thrown open several weeks earlier than usual. This undoubtedly saved a large number of stock.

Naturally, after such a winter the lamb and calf crops were considerably below the average, although much above what was looked for. With hay so high the cost of lambing in sheds was much greater than usual, but those sheepmen who lambled under such conditions were well repaid by the increased lamb crop secured. Once the spring opened, however, and the weather began to moderate, the grasses and forage plants made rapid advances, since the soil was unusually moist.

At the close of the fiscal year the condition of both stock and feed on all the National Forests was in general above the average for the last 10 years, and the outlook for fat cattle, sheep, and lambs in the fall was excellent.

The number of fat stock turned off from the Forests in the fall of 1919 was fully equal to the average year, in spite of the drought. In fact, on many Forests all stock, especially cattle, were in much better shipping condition than usual. This has been noticed in previous years of drought and is presumably due to the more fully developed condition of the forage plants. The dry weather also made possible the full use of many swampy, wet meadows from which little feed can ordinarily be obtained.

The high prices of hay and concentrated feeds in the fall of 1919 and the prospects of a long winter-feeding period caused large numbers of stock to be marketed or shipped to points where feed could be obtained at more reasonable rates. The stock marketed was sold at considerable reductions from the prices of the previous three years.



When the cold weather broke in the spring of 1920 and the grass finally began to grow, the stockmen, always hopeful and seeing promise of plenty of grass, undertook to replenish. This at once sent the prices of stock up to almost the former levels.

About the middle of May, however, financial complications affected the buying of wool and cattle. The buying of wool stopped almost within a day, and prices dropped from above 60 cents a pound for western range wool to around 25 cents, with practically no market at any price. Prices of beef and cattle also declined seriously.

**USE OF THE RANGE.**—While adverse market conditions if long-continued will be reflected in reduced numbers of western live stock, use of the National Forest ranges will not permanently be lessened; for their carrying capacity is so far below the demand that where one man drops out others will immediately apply for the vacated range. Irrespective, therefore, of prosperity or lack of prosperity in the live-stock business, the number of stock on the National Forests bids fair to be reasonably constant, and near the limit set by the necessity of maintaining the productiveness of the ranges at their maximum.

*Number of stock grazed during the fiscal year.*—The following table shows the number of stock grazed on the National Forests for the fiscal year:

*Grazing permits issued and number of stock grazed, 1920.*

State.	Cattle, horses, and swine.				Sheep and goats.		
	Permits issued.	Number of stock grazed.			Permits issued.	Number of stock grazed.	
		Cattle.	Horses.	Swine.		Sheep.	Goats.
Alabama.....	10	133					
Arizona.....	1,585	346,739	4,870	563	139	346,046	5,742
Arkansas.....	233	3,427	31	107	3	32	67
California.....	2,834	202,378	6,536	2,272	495	515,558	13,300
Colorado.....	4,482	372,582	8,962	17	788	1,018,499	1,121
Florida.....	66	1,242		162	7	1,300	45
Georgia.....	51	442	46	3	1	5	
Idaho.....	4,082	173,089	12,902		1,027	1,686,681	
Montana.....	2,872	164,488	14,701	277	441	704,507	134
Nebraska.....	55	14,138	620				
Nevada.....	501	76,123	3,942		109	347,860	
New Hampshire.....	19	154	29				
New Mexico.....	1,844	167,630	3,844	295	537	402,728	33,056
North Carolina.....	250	1,516	62	62	4	78	60
Oklahoma.....	58	3,665	238				
Oregon.....	2,327	158,698	8,451	159	494	684,873	160
South Dakota.....	744	32,706	2,814		7	7,085	
Tennessee.....	51	487		2	6	77	
Utah.....	6,998	163,535	8,869	147	1,641	757,724	
Virginia.....	265	2,810	2		3	49	
Washington.....	871	29,728	2,446		176	226,769	
West Virginia.....	3	32			1	17	
Wyoming.....	1,100	119,690	3,869		299	589,696	
Total, 1920.....	31,301	2,035,432	83,234	4,066	6,178	7,280,584	53,685
Total, 1919.....	32,528	2,135,527	93,251	5,154	6,624	7,935,174	60,789

These figures show a considerable reduction from the totals of the previous year. This was due chiefly to the heavy depletion of range stock in the Northwestern States during the winter of 1919-20, by death, by shipping to market, and by shipping out to regions where feed could be procured. Had it been possible to foresee the decline in numbers of stock which would be grazed by established permittees, new applicants could easily have been found, but when

the deficiency in the numbers entering the ranges became apparent it was too late to secure other applications. The shortage, however, was really a benefit to the ranges, many of which were somewhat overgrazed in consequence of the increases made during the war when the needs of the Nation demanded that every animal the ranges would carry be placed upon them.

**RANGE IMPROVEMENTS.**—A reduced appropriation for range improvements has forced a large curtailment of work of this kind. Drift fences which hold cattle on their allotted ranges and prevent losses by theft and straying, trails and bridges which open up unused ranges, and watering places increase the number of stock that a given range can carry, as well as bringing about economies of operation. They produce increased returns in income to the Government from the very first year they are installed. The former appropriations for them should be not only restored but very substantially increased.

The productivity of the National Forest ranges in live-stock products as well as in public revenues can be vastly increased by systematic improvements. Hitherto this work has progressed at a snail's pace and piecemeal. It has depended upon voluntary assistance and the payment of a large part of the cost by range users. From every standpoint, especially that of national food supply, the time has come when the Federal Government should undertake this work systematically by the expenditure of its own funds. The increased number of live stock that can thus be carried on the ranges and the increased value of the forage to grazing permittees will make it possible to recoup the Federal Treasury for outlays in range improvements within from five to seven years. Future range improvements should as far as practicable be constructed in accordance with such a plan.

**LIVE STOCK ASSOCIATIONS.**—Our relations with the western stockmen through the many live-stock associations formed by permittees upon the National Forests continue to be extremely satisfactory and helpful. Through them many difficult range controversies have been satisfactorily cleared up. The benefits obtainable by permittees through cooperation between these associations and the Forest Service have striking illustration in the matter of purebred bulls.

Several States have laws which require stockmen using the public domain to turn out only bulls which are pure bloods or registered. The enforcement of these laws, however, is usually difficult, because there is no official of the State whose duty it is to attend to it. On the National Forests the Forest Service may and does require the compliance of range users with any special rules looking to more advantageous use of the range which the stockmen may, through these associations, adopt and the Service itself may approve. In many cases such special rules have been adopted requiring each permittee to provide purebred or registered bulls to the full number called for under the law. Failure to comply with such rules may deprive the permittee of his grazing preference. The benefits derived from these requirements become very quickly and markedly apparent in improved size, conformation, color, etc., of the stock. The fact that such requirements are in force on the Forest ranges naturally affects the outside public domain ranges, and thus the whole range stock industry in the vicinity is greatly improved.

Forest officers are instructed to aid in the creation of new associations of this character and the upbuilding and support of those already in existence.

**GRAZING FEES.**—On February 1, 1917, the Secretary of Agriculture announced that grazing fees would be based upon the real value of the forage utilized. Valuation studies in the western range districts were undertaken, and on March 1, 1919, the grazing fees formerly in effect were approximately doubled. The fees then established by the Secretary of Agriculture, which greatly increased the receipts from the National Forests, represented the best judgment of the department as to the actual value of the ranges under market conditions prior to that time, taking into account the restrictions placed upon their use by Forest Service regulations.

This increase in grazing fees, while a definite step in business management, failed to take into account many differences in range values. The fees charged on different National Forests vary somewhat in accordance with the quality and accessibility of their ranges; but on each Forest the same fee has been charged for the same grazing season, notwithstanding marked differences in the value of the pastures. It was not possible in 1918 to consider all of these factors. While the general standard of grazing fees has been below what the abnormal live-stock and forage values in 1919 might have justified, the charges for some of the relatively inferior ranges are fully equal to their fair value. It is particularly important to recognize this in view of the fact that general business conditions are operating to reduce values in the industry.

To determine the grazing fees in full justice to the stockmen and the public, the National Forest ranges must be classified by smaller units and the charges fixed in accordance with the grazing value of each unit. This involves quality and accessibility of forage, adequacy of water, unavoidable losses in handling stock on account of topography or the existence of poisonous plants, and the like. Such a classification will require a deal of careful study on the ground, but is fundamental to a businesslike handling of the National Forest ranges in the future. A field appraisal will be made and the ranges classified during the ensuing two years. A schedule of grazing fees based on the fair commercial value of each class of range will be prepared by 1923 and submitted to the live-stock associations, in order that errors may be corrected and ample opportunity given for a hearing before the charges are approved. The new fees should become effective in the grazing season of 1924.

Under authority from the Secretary of Agriculture, a large number of permits were issued in 1919 granting the use of National Forest ranges for a period of five years. These permits were issued with an understanding between the Government and the western settlers and stock growers that grazing fees would not be increased during the five-year period. That understanding should not be repudiated by the Government. Such a course would be a breach of good faith and a serious injury to the live-stock industry over a considerable region within which its stability depends to a large degree upon the fairness of National Forest rules and the dependence which can be placed upon their enforcement. While the inflated



values of forage in the Western States have in many cases gone beyond the charges for National Forest range, this fact is no ground for a hasty advance in grazing fees in violation of the good faith of the department. Systematic range classification affords a much fairer and more accurate basis for dealing with this situation.

## WATER POWER.

The Forest Service handled relatively little new water-power work during the fiscal year 1920, most of the intending developers of water power preferring to wait until the new legislation was passed before applying for Federal authority in connection with their projects. The Federal water-power act was finally approved June 10, 1920, and it is confidently hoped that development under this act will begin in the very near future on a large scale. The electric power industry is at present largely underdeveloped, and additional developments are urgently needed to meet existing and prospective load demands.

The receipts from water-power permits and easements were \$88,906.84, as compared with \$72,322.06 for the fiscal year 1919. Twenty applications for preliminary rental permits were received, 14 for final rental permits, of which 8 were for transmission lines only, and 8 for free permits or easements, of which 3 were for transmission lines only.

Data concerning projects under permit at the close of the fiscal year are given in the accompanying table.

*Water-power sites and transmission-line rights of way under permit and easement, fiscal year 1920.*

Class of permits or easements.	Transmission lines only.			Power projects (reservoirs, conduits, and power houses.)		Total number permits or easements.
	Number of permits or easements.	Length in miles.		Number permits or easements.	Estimated average output (in horsepower) at minimum discharge.	
		Within National Forest boundaries.	On National Forest land.			
Permits or easements in force at close of fiscal year:						
Rental—						
Preliminary.....				10	531,517	10
Final.....	158	1,096.60	818.79	92	687,622	250
Free permits or easements...	24	155.42	122.38	101	24,338	125
Total.....	182	1,252.02	941.17	203	1,243,477	385
Construction completed at close of fiscal year:						
Rental permits or easements.	156	1,138.02	814.81	76	335,263	232
Free permits or easements...	24	155.42	122.38	82	7,643	106
Total.....	180	1,293.44	937.19	158	342,306	338
Construction incomplete at close of fiscal year:						
Rental permits or easements.	1	5.56	2.06	14	329,795	15
Free permits or easements...				15	652	15
Total.....	1	5.56	2.06	29	330,357	30
Construction not started at close of fiscal year:						
Rental permits or easements.	1	3.02	1.92	12	453,081	13
Free permits or easements...				4	16,707	4
Total.....	1	3.02	1.92	16	469,788	17

## RECREATION AND GAME.

The use of the National Forests for recreation purposes is increasing rapidly. This use is not confined to a few well-advertised regions of special attractiveness, but is noticeable in almost all of the 152 Forests. It is common to the White Mountains, the southern Appalachians, the forests of Minnesota, the Rocky Mountains, the Cascade and Sierras, and the alluring tablelands of Arizona and New Mexico. As an important use it bids fair to rank third among the major services performed by the National Forests, with only timber production and stream-flow regulation taking precedence of it.

The growth of this form of use shows clearly the inadvisability of legislation at one time contemplated, which by opening the National Forests to "summer homesteads" would have allowed private acquisition of tracts exceedingly valuable for public recreational purposes. Such a system would have blocked general use of these great Forests for public recreation. Instead the act of March 4, 1915, gave the Secretary of Agriculture authority to issue term permits for not to exceed 5 acres of National Forest lands for periods not to exceed 30 years. Under this law reasonable tenure can be given where substantial investments are contemplated upon areas not needed in the meantime by the public. In carrying out this act the Forest Service has engaged in a very extensive development. Counsel and advice have been secured from competent landscape engineers, and the guiding policy has been worked out in cooperation with the foremost national authorities on such subjects. Always general use by the public, through the reservation of open camp grounds, has been given first consideration. Special use by individuals who pay rental has been made secondary to the needs of the public.

Yet such secondary use is now becoming a very material source of revenue. At the close of the fiscal year a total of 1,329 permits for summer residences and commercial resorts were in effect on a single Forest, the Angeles, in southern California. The revenue from this one item on this Forest alone amounted last year to approximately \$22,000. The local officers predict that within a few years the revenues obtained from the various recreational settlements within that Forest will pay the entire cost of protection and administration. Yet the maximum charge for residence permits within the National Forests has been fixed by regulation at \$25 per annum, and the minimum is \$5.

The use of the National Forests for recreation is being recognized by many communities as one of their greatest assets and privileges. This is resulting in the establishment of community camps under more or less formal organization. They take every form from the municipal vacation camps erected on the Angeles National Forest under permit from the Forest Service and maintained and managed by the city of Los Angeles to the improvement of some favorite picnic ground in the National Forest by local citizens in cooperation with the local forest officers. Space is provided for parking automobiles, simple permanent fireplaces are built, wood is made available for camp fires and cooking without endangering the Forest from fires, rustic tables and seats are located conveniently for different parties.

signs indicate the direction and distance to attractive points, and public convenience is given thoughtful consideration. Similar improvements are made by the Forest Service when funds are available and local cooperation can not be obtained to meet a real public need. These camps are made available to the public without charge of any kind by the Forest Service. The vacation camps, such as those maintained by Los Angeles, require a charge merely sufficient to cover the expense of feeding and caring for the successive groups of city patrons who enjoy its privileges under municipal direction.

The appeal for local recreational facilities and the demand for summer-home sites are growing so rapidly that there is need for men of special training to direct and plan for the most effective development of this service. Many communities are subscribing liberally for the erection of improvements upon the National Forests for public convenience. To bring about the fullest use of the National Forests and contribute their proper quota to the Nation's health, there is needed a special fund of \$50,000 for recreational development. This will permit the employment of several trained landscape engineers, more rapid and at the same time more careful development, the improvement of additional camp grounds and provision of other public facilities and conveniences, and enlarged cooperation with local communities. This is certainly good business policy; the increased receipts from individual home sites, which is only one by-product of our recreational work, will return to the Treasury much more than the total amount to be expended for recreational development.

Closely related with the development of our recreational resources is the use of the National Forests as the habitat of fish and game and the protection of wild life as a great public resource. Game protection is one of the regular activities of the field officers of the Forest Service. Cooperation with the State and local authorities in enforcing the game laws has contributed in no small degree toward making our National Forests more attractive to visitors and conserving one of their most valuable resources. This work will be continued in the future along the same broad lines.

To make this work most effective and to secure better development of the fish and game resources of the National Forests, Congress should make provision for the establishment of game sanctuaries within which wild life may find security. These should be relatively limited in area, but should be established in considerable number. Their location will require careful preliminary field investigation and close cooperation with the State authorities. A favorable report has already been submitted to Congress upon one such measure, which would empower the President to establish such game sanctuaries within the National Forests of any State where their establishment is sanctioned by the State legislature.

In this connection special mention should be made of the necessity of additional protection for the harassed and decimated herds of elk using the Yellowstone National Park and the surrounding Forests. Famine and cold last winter took an unusually heavy toll from their number. Driven out of the high country by starvation and early deep snows, the northern herd suffered from hunters along the



boundary line a percentage loss equal to that of a defeated army. Many that escaped the hunters perished from cold and starvation before spring. The southern herd also lost heavily. As a result, the total number of animals in these two herds is now estimated by the best qualified officers in the Forest Service to equal one-half of their number five years ago.

The Forest Service, in close cooperation with the Biological Survey, will continue to do all in its power to help preserve these great herds from destruction by neglect. Congress should add to the Absaroka and Gallatin Forests the lands still in Government ownership now under withdrawal along the Yellowstone River north of Gardiner. This land is urgently needed as winter range for the elk. Local settlers need not be excluded from the continued use of this range, for the small number of stock owned by them can easily be taken care of without materially affecting the well-being of the elk. If Congress makes the addition as recommended, its use by both game and domestic stock can be worked out without injury or injustice to any of the local residents. If this action is not taken the outlook for the northern elk herd is gloomy indeed. The prospects for the southern herd are more bright; but additional purchases of land for winter feeding grounds appear absolutely essential.

#### ROADS, TRAILS, AND OTHER IMPROVEMENTS.

The mileage of road and trail construction during 1919 eclipsed all previous figures. This is the more notable in view of the high cost and scarcity of labor. The large amount of investigative and survey work was carried on during 1918, when construction was restricted to projects that would contribute toward the prosecution of the war, aided materially in getting work under way early in 1919. This was particularly true of administrative and protective roads and trails. Special effort has been made to complete as quickly as possible the roads and trails essential to an effective system of fire protection; but although excellent progress has been made, a tremendous amount of transportation development remains to be accomplished before all danger points can be reached quickly. The accessibility of the forests for recreation has been greatly increased by the completion of many of the projects.

The following tabulation shows the number of miles of public roads and trails constructed or improved during the calendar year 1919, and also the total at the close of the year. These figures include the work surveyed and constructed under the immediate supervision of the Bureau of Public Roads as well as that of the Forest Service:

*Construction and improvement of roads and trails<sup>1</sup> from road appropriations and cooperative funds, by States.*

State.	Calendar year 1919.		Total to Dec. 31, 1919.	
	New construction.	Repairs.	New construction.	Repairs.
	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>
Alaska.....	11.5	6.0	32.9	6.0
Arizona.....	74.9	.....	194.4	15.5
Arkansas.....	7.1	.....	27.6	.....
California.....	182.7	1,419.7	442.1	1,484.7
Colorado.....	253.6	81.0	364.0	102.5
Florida.....	40.0	.....	40.0	.....
Georgia.....	2.0	40.0	2.0	40.0
Idaho.....	256.1	137.4	344.1	314.5
Maine.....	14.0	11.0	14.0	11.0
Michigan.....	.....	30.9	.....	31.0
Minnesota.....	3.4	.....	3.8	1.6
Montana.....	173.8	51.4	254.1	186.4
Nebraska.....	.....	.....	2.1	2.5
Nevada.....	52.5	4.0	77.8	118.5
New Hampshire.....	21.0	190.0	21.0	190.0
New Mexico.....	177.8	.....	230.5	24.8
North Carolina.....	40.0	120.0	40.0	120.0
Oklahoma.....	.....	10.0	.....	10.0
Oregon.....	175.4	956.0	137.0	876.1
Porto Rico.....	16.0	.....	16.0	.....
South Dakota.....	12.7	.....	25.3	8.2
Utah.....	391.6	83.5	502.3	184.9
Virginia.....	5.0	128.2	6.0	128.2
Washington.....	137.6	1,665.8	205.9	1,763.7
West Virginia.....	.....	6.0	.....	6.0
Wyoming.....	149.1	58.5	203.5	87.0
Total.....	<sup>2</sup> 2,197.8	<sup>3</sup> 4,999.4	<sup>4</sup> 3,186.4	<sup>5</sup> 5,713.1

<sup>1</sup> Does not include maintenance work.<sup>2</sup> 798.9 miles of roads, 1,398.9 miles of trails.<sup>3</sup> 1,083.3 miles of roads, 3,916.1 miles of trails.<sup>4</sup> 1,609.5 miles of roads, 1,576.9 miles of trails.<sup>5</sup> 1,786 miles of roads, 3,927.1 miles of trails.

The road and trail construction work in the National Forests is financed from appropriations under three different acts of Congress.

The first is the appropriation known commonly as the "10 per cent fund," based on the item in the Agricultural appropriation act of March 4, 1913, which sets aside 10 per cent of the National Forest receipts each year for road and trail improvement. This money must be expended in the States in which the receipts originated and the expenditures must be confined to improvements entirely within the Forest boundaries. This appropriation now amounts to nearly a half-million dollars a year.

The second source from which Federal funds are provided is under section 8 of the Federal aid road act of July 11, 1916. In this section Congress appropriated \$1,000,000 a year for National Forest roads for a period of 10 years. The last appropriation will become available on July 1, 1925. The money available under this act is commonly termed the "section 8 fund." It must be expended in cooperation with the proper authorities of the States or counties.

The third provision for National Forest road funds was made in section 8 of the Post Office appropriation act of February 20, 1919, which made available \$9,000,000, at the rate of \$3,000,000 a year, beginning with the fiscal year 1919. The last installment of this appropriation was received on July 1, 1920. These funds may be expended within the Forests without requiring cooperative contributions from the States or counties, but if part of the work lies outside of the Forest boundaries it is necessary that cooperative funds be provided.

Through a cooperative arrangement the road projects which require the supervision of engineers intensively trained in highway engineering and construction are handled by the Bureau of Public Roads. Numerous road improvement and repair projects are required primarily for the administrative and protective needs on the National Forests. The standards set for such work aim more at utility combined with economy than the higher types of construction, and the work calls more largely for practical, rough-and-ready methods than for technical engineering skill. This work, together with trail-building and maintenance, is handled directly by the Forest Service in conjunction with administration, protection, and other activities on the Forests. It is coordinated with fire protection as far as possible, so that construction crews may be available in remote areas of great fire hazard as part of the fire-suppression organization. Very gratifying results from a protection standpoint have come about through the operation of this plan.

In the following tabulation are shown the projects approved and the liabilities involved during the fiscal year and prior to that time:

*Summary of road and bridge projects undertaken to end of fiscal year 1920.<sup>1</sup>*

NUMBER AND LENGTH OF PROJECT.

Status of projects.	Survey.		Construction.		Bridges.
	Number.	Miles.	Number.	Miles.	Number.
Approved during fiscal year.....	78	1,229.40	74	1,166.00	2
Total approved to June 30, 1920.....	221	3,676.41	217	3,309.39	7

LIABILITIES.

Status of projects.	Federal.	Local authority.	Total.
Approved during fiscal year.....	\$7,272,390.00	\$4,397,732.00	\$11,670,122.00
Total approved to June 30, 1920.....	16,011,417.00	8,851,556.00	24,862,973.00

<sup>1</sup> Does not include 10 per cent projects completed prior to Jan. 1, 1919, and minor administrative and protective roads and trails.

The expenditures during the calendar year 1919 for all road activities, including the surveys, construction, repairs, equipment, investigations, and overhead, amounted to \$4,582,022. Of this \$297,637 was from the 10 per cent fund, \$1,449,189 from the section 8 fund, and \$1,504,182 from the Federal Forest road construction fund. The balance of the total is represented by \$1,230,994, expended from cooperative funds contributed by States and counties.

The following tabulation indicates the condition of the three road appropriations on January 1, 1920:

*Condition of road appropriations.*

Fund.	Total available.	Total expended.	Unexpended balance.
10 per cent.....	\$2,322,225.96	\$1,643,282.72	\$678,943.24
Section 8.....	4,000,000.00	1,921,025.20	2,078,974.80
Federal Forest road construction.....	6,000,000.00	1,504,181.59	4,495,818.41
Total.....	12,322,225.96	5,068,489.51	7,253,736.45

Additional installments of these appropriations which became available for expenditure on July 1, 1920, aggregate \$4,472,025.25.



The distribution among States of the amounts available for roads and trails from new appropriations available on July 1, 1920, are indicated below.

State.	10 per cent.	Section 8.	1921 Federal Forest road construction.
Alaska.....	\$10,692.15	\$44,935.00	\$89,386.00
Arizona.....	49,851.27	54,858.00	137,173.00
Arkansas.....	7,100.83	9,619.00	21,825.00
California.....	72,401.33	137,586.00	360,000.00
Colorado.....	47,494.80	64,966.00	159,893.00
Idaho.....	49,939.12	105,569.00	436,353.00
Montana.....	35,206.87	71,353.00	232,000.00
Nevada.....	11,483.89	19,045.00	.....
New Mexico.....	31,144.97	39,018.00	182,200.00
Oregon.....	48,649.40	130,071.00	237,595.00
South Dakota.....	8,609.00	8,039.00	27,019.00
Utah.....	26,204.37	40,493.00	108,850.00
Washington.....	29,704.76	90,880.00	195,644.00
Wyoming.....	25,230.30	42,230.00	60,307.00
Florida.....	2,444.83	12,187.00	20,596.00
Michigan.....	153.31		
Minnesota.....	2,663.69		
Nebraska.....	1,549.08		
Oklahoma.....	566.26		
Porto Rico.....	.....	29,111.00	131,159.00
Alabama.....	58.73		
Georgia.....	725.57		
Maine.....	169.97		
New Hampshire.....	2,168.67		
North Carolina.....	3,064.66		
South Carolina.....	68.36		
Tennessee.....	2,402.80		
Virginia.....	2,155.25		
West Virginia.....	211.01		
Special fund <sup>1</sup> .....	.....	100,000.00	.....
Equipment.....	.....	.....	111,600.00
Administrative expenses.....	.....	.....	300,000.00
Unallotted balance.....	.....	.....	189,000.00
Total.....	472,025.25	1,000,000.00	3,000,000.00

<sup>1</sup> For administrative expenses, for purchase of equipment, and for increasing apportionments to States.

An intensive administrative and economic study of road needs, begun in 1918, indicates that to equip the National Forests adequately with the roads and trails necessary for their proper administration, protection, and full usefulness to the public will require an aggregate investment far beyond anything yet provided for. The total expenditure, approved from Federal funds for the calendar year 1920, is \$8,127,323, which will leave a balance on January 1, 1921, of only about \$3,600,000 in all appropriations. After January 1, 1921, there will be no further appropriations from the Federal Forest road-construction fund, and only \$1,000,000 will be available annually from the section 8 fund. It is clearly evident that the program of development on which so excellent a start has been made the last two years must be sharply curtailed unless additional funds are provided at once.

It is believed that approximately three-quarters of the approved work for the calendar year 1920 will be completed in spite of the fact that increases in the estimated or actual costs, difficulties in obtaining cooperation from local agencies, and the difficulty in securing reasonable bids from contractors have caused a reduction in the amount of work.

The transfer from the War Department of surplus materials, equipment, and supplies suitable for use in road improvement has

progressed rather slowly, and as a result a considerable amount of equipment had to be purchased. It is hoped that a substantial saving in construction costs will result when the transfer of sufficient equipment and supplies for the needs of the National Forest work is accomplished.

The construction of improvements of all kinds during the fiscal year comprised 1,082 miles of roads; 1,504 miles of trails; 722 miles of telephone lines; 17 miles of fire lines; 37 lookout structures; 44 bridges; 253 miles of fences; 382 dwellings, barns, and other buildings; 9 corrals; and 179 water improvements. Of these, 687 miles of roads, 158 miles of trails, 84 miles of telephone lines, 124 miles of stock fences, 10 miles of fire lines, 11 bridges, 31 water improvements, 4 corrals, 3 lookouts, and 1 other structure were built in cooperation with communities, associations, and individuals.

The value of all improvements on the National Forests at the close of the year constructed from funds derived from congressional appropriations and the contributions of cooperators is estimated at \$12,956,829. Of this amount \$10,602,906, or 81.8 per cent, represents works of communication and protection; \$2,007,244, or 15.5 per cent, improvements used in administration; and \$346,679, or 2.7 per cent, range improvements. The lines of communication within the Forests constructed by or under the direction of the Forest Service now total 5,043 miles of roads, 29,419 miles of trails, and 25,031 miles of telephone lines.

#### COOPERATION WITH STATES.

Expenditures from the appropriation of \$100,000 made by Congress for fire protection on the forested watersheds of navigable streams in cooperation with the States, and the expenditures of the States which have entered into cooperative agreements for this purpose, are shown in the following table:

*Cooperative expenditures, fiscal year 1920, from Federal appropriations and by the States for protecting forested watersheds of navigable streams from fire.*

State.	Federal.	State.	Total.
Maine.....	\$10,432.25	\$116,844.11	\$127,276.36
New Hampshire.....	6,073.02	24,739.15	30,812.17
Vermont.....	1,978.00	5,879.46	7,857.46
Massachusetts.....	3,840.75	39,333.60	43,174.35
Rhode Island.....	294.00	1,762.45	2,056.45
Connecticut.....	932.25	4,839.27	5,771.52
New York.....	5,150.37	132,528.56	137,678.93
New Jersey.....	2,120.41	21,703.83	23,824.24
Pennsylvania.....	4,024.24	56,768.61	60,792.85
Maryland.....	1,790.55	4,585.84	6,376.39
Virginia.....	4,650.00	6,886.23	11,536.23
West Virginia.....	5,085.00	10,634.01	15,739.01
North Carolina.....	1,851.04	3,011.13	4,862.17
Kentucky.....	1,739.50	1,705.00	3,444.50
Louisiana.....	1,365.50	2,521.35	4,186.85
Texas.....	2,361.31	4,350.27	6,711.58
Michigan.....	2,110.00	60,586.46	62,696.46
Wisconsin.....	3,518.57	21,942.28	25,460.85
Minnesota.....	6,067.34	104,096.03	110,163.37
South Dakota.....	94.00	3,501.00	3,595.00
Montana.....	254.50	51,549.50	51,804.00
Idaho.....	5,415.50	92,524.37	97,939.87
Washington.....	5,206.00	48,951.84	54,157.84
Oregon.....	6,306.23	28,787.86	35,094.09
California.....	1,995.96	10,196.53	12,192.49
Administration and inspection.....	8,181.57	.....	8,181.57
Total.....	92,837.86	860,548.24	953,386.10
Unexpended balance.....	7,162.14	.....	7,162.14
Appropriation.....	100,000.00	.....	100,000.00

Cooperation was inaugurated with two new States—California and Pennsylvania. The fire-protection needs of both of these States are large, requiring funds many times greater than could be provided. Two of the older States suspended cooperation, owing to State departmental difficulties. With one of these States—South Dakota—cooperation was revived toward the very close of the year. In the other—Kentucky—the difficulties are of more serious character, since the State has withdrawn its support from forestry and forest-fire prevention. At the close of the year 24 States were co-operating actively with the Federal Government.

Cooperation with the States in fire protection has shrunk during the year, measured in terms of actual activity. This is because, with the same funds available, it has been possible to hire on the average only about two-thirds the number of men formerly employed. In some States the shrinkage has been even greater. This circumstance created a serious condition in many of the States, particularly in the West, where a most severe fire season impelled an expansion in all fire-protection activities.

The States with which the Forest Service now cooperates in fire prevention to the extent of its very limited funds contain approximately 150,000,000 acres of forest land which are under some form of protection. The same States contain at least 65,000,000 acres of forest land which is largely or wholly unprotected from fire. There are 11 additional States which should join forces with the Federal Government in forest-fire prevention. These States contain at least 100,000,000 acres of forest land now almost wholly without protection of any kind. In other words, out of a total of 315,000,000 acres of private forest land upon which we depend for future supplies of timber less than one-half is now being protected from fire.

Lack of protection applies particularly to the enormous areas of logged-off land where rapid second growth should now be taking place. The destruction every year of all young growth, aside from much merchantable timber, on enormous areas of forest land is the very root of timber depletion and future shortages of essential forest products. The first essential step in a national forestry policy is to put an end to this wasteful and unnecessary destruction by forest fires.

Forest-fire statistics collected, as in former years, in cooperation with States and private agencies indicated that the total number of recorded fires throughout the country during the calendar year 1919 was more than 27,000, the damage \$14,500,000, and the area burned 8,250,000 acres. These figures are below the average for the four years 1916 to 1919, and indicate that taking the country as a whole the season was an unusually favorable one except for the West. Over one-third the total number of fires and total area burned and over one-half the damage in 1919 occurred west of the Great Plains.

## RESEARCH.

### FOREST PRODUCTS.

The year marked the completion of 10 years of research by the Forest Products Laboratory at Madison, Wis. Its work, at first little appreciated, is now generally recognized both in this country



and abroad as of immense value to science and industry. In all, the investigations of the Laboratory have cost about \$2,000,000 and are believed to be now saving industry at least \$30,000,000 annually. But its value is not confined to such benefits. If the material from an acre of forest can be made to go twice as far or to last twice as long as formerly the result is the same as if the production of that acre were doubled. Investigations leading to the more efficient utilization of forest products are thus an integral part of any comprehensive program aimed at the perpetuation of our forest resources.

The ending of the war did not terminate investigations connected with the national defense. Many projects undertaken during the war were completed and a number of new projects were started, including the design of various types of airplane struts and the development of a plywood airplane wing. Extensive tests were made on white ash and other species to determine the effect of spiral grain and of various other defects and blemishes on strength.

In addition to specific designs the closer utilization of existing supplies of aircraft woods was investigated and types of built-up beams were developed. The laboratory will make investigations connected in one way or another with the national defense a part of its regular program, in cooperation with the War and Navy Departments.

Knowledge of the mechanical properties of wood was extended through 62,000 tests, covering 57 different species. The total number of such tests made by the laboratory is now 500,000. Among the subjects of investigation were the effect of commercial processes of wood preservation on the strength of structural timber, the toughness and shearing strength of various kinds of plywood, its bolt-bearing and screw-fastening properties, and the impairment of strength of wood under continuous vibration. The services of the box-testing laboratory were extensively used by manufacturers and shippers. Several private box-testing laboratories modeled on that at Madison have been built. The best methods of packing various commodities, such as shoes, phonographs, cream separators, and scrubbing machines, and the design of containers of the highest efficiency and lowest cost, were subjects of continuous study. Tests of the value of western woods for box making resulted in establishing white fir, formerly thought to be of little value for boxes, as a commercial box wood.

Further studies were made to improve the formulas for waterproof glues for plywood manufacture. Information on the preparation and use of various glues was furnished to numerous commercial manufacturers. Special courses of instruction were given to representatives of glue and plywood users.

The study of stresses in composite pieces of wood glued in varying combinations was completed, with results that will be of value in all kinds of built-up construction. Studies of the conditioning and manufacture of airplane propellers were continued and recommendations made for the revision of present manufacturing specifications. Manufacture and test of various types of joints and splices in propeller laminations furnished information of value to propeller manufacturers and others whose work requires the joining of pieces to form large boards.

A 40-page catalogue of service tests of railroad ties, covering all installations on which the laboratory is keeping inspection records, was completed and printed in the 1920 proceedings of the American Wood Preservers' Association. This information is of great value to railway engineers and wood preservers. Service-test records of posts, poles, piling, and other forms of timber were obtained and made available to farmers, telephone and electric companies, engineers, and architects. As a result of experiments by the laboratory demonstrating the value of sodium fluoride, two railroad companies and one mining company have decided to use this material for the preservative treatment of railroad ties.

The effect of different amounts of various chemicals added to hardwoods previous to distillation has been studied. It was found that the addition of a small amount of sodium carbonate increases the yield of wood alcohol by from 50 to 60 per cent without seriously affecting the yields of the other valuable products. The method is effective, however, only when the material for distillation is in the form of small pieces of wood or sawdust briquettes. In cooperation with the Bureau of Mines, a study was started to determine the value of different fractions of hardwood tar as flotation oils. The cooperators have already reported that certain of the tar-oil fractions show great promise of becoming excellent substitutes for pine oil, which is the most universal and most expensive flotation oil now in use.

A line of work which may lead to results of far-reaching importance was the production of a stock food by a process similar to that developed for the manufacture of ethyl alcohol from sawdust. In this process the wood cellulose is first converted into a sugar by treating the sawdust with a dilute solution of sulphuric acid under pressure. The acid is then neutralized and the sugar solution after evaporation to a thick molasses is combined with the dried residue to form a brownish meal somewhat resembling bran. A stock feed prepared in this way showed, on preliminary tests, great promise of being a valuable carbohydrate food.

The study of seasoning southern swamp oaks in vehicle sizes represents one of the two most important new investigations in kiln drying undertaken during the year. The other is an investigation into the operation of commercial kilns of various types, with special reference to drying efficiency, cost of operation, and relative cost of kiln drying and air drying. Investigations have been completed at two plants and are under way at a third. The experimental work on the effect of kiln drying on the strength of aircraft woods has been nearly completed, only a few kiln runs on cypress still remaining to be done.

Giving advice to commercial concerns in the solution of their kiln-drying problems is a matter of daily routine. While the majority of the requests for help are handled through the mails, many manufacturers and engineers visit the laboratory to receive more detailed assistance. The saving in stock, time, and otherwise brought about by the application of this advice has been very great, amounting in at least one case to as much as \$300 per day. Forest Service water spray kilns have proved so satisfactory in actual operation that they have been installed or are being built not only in the United States but in India, Australia, New Zealand, and Mexico.

Work on the production of book and similar papers from cotton linters was continued, and mill tests have demonstrated that a very high grade of paper can be made. Two large companies are now erecting plants for the manufacture of paper from this material, basing their plans largely on the experimental work conducted by the laboratory. Work was continued on the determination of the suitability of wood pulp for the manufacture of nitrocellulose, and an acceptable pulp was developed for the use of the Ordnance Corps.

A comprehensive study was made of the influence of decay in wood on the quantity and quality of pulp produced. Infected wood is estimated to cause losses in pulp yields of up to 20 per cent, while the losses in stored pulp are probably at least \$5,000,000 a year. The effect of a wide variety of preservatives on ground wood pulp lumps, the infection of wood under various moisture conditions, the isolation and identification of the organisms causing decay, and the local conditions under which pulp is stored were investigated.

Efforts to get the results of investigations widely known and practically applied included publication through Government bulletins, periodical articles, and mimeographed technical notes; commercial demonstrations of new and improved methods; cooperative instruction courses; and the maintenance of close contact with the wood-using industries generally.

These measures facilitated the early and general utilization of results and brought more requests for assistance than could possibly be met. Practical training courses in kiln-drying, glue work, and boxing and crating have been developed to meet these requests more effectively. These courses, largely attended by factory superintendents, have proved one of the most satisfactory means of getting the results of the laboratory into actual use.

A much wider use by American industries of the practical results of the studies could readily be brought about. A large percentage of the time of the research staff is being given to the handling of inquiries, to the detriment of further study of problems that are of urgent importance. To preserve a proper balance between research essential to further progress and efforts to secure application of the results of past research, either the working force must be increased or a limitation must be placed on the time given to making results available to industry.

In the National Forest districts in the West the work in forest products consisted largely in the advising of administrative officers on current problems connected with forest and wood utilization and the development of markets for the closer utilization of National Forest timber. Time and cost studies of logging and milling operations were also conducted, the results of which will be of value both to private operators and in National Forest administration.

#### FOREST MANAGEMENT.

Under this head is included a wide range of investigations having to do with the botanical and silvical characteristics of trees and forests and with their protection, reproduction, and growth. In nearly all of them observations covering many years are necessary to establish definite conclusions. For this reason the bulk of the work is being centralized as rapidly as possible at Forest experi-



ment stations, where continuous records and observations can be maintained indefinitely.

In the numerous studies in tree planting, which have occupied much attention for the last 5 or 10 years, much progress has been made. These studies have been directed largely toward determining the best methods of nursery practice and of field planting and sowing. They have aided largely in developing the science of tree planting in the National Forest regions, and their results are being constantly utilized in the large-scale operations carried on by the Service. The planting investigations which now remain are largely observations over long periods in order to establish the final conclusions definitely and the improvement of methods whose general features have been developed. Meantime greater emphasis is being given, in research, to the best methods of cutting in order to secure satisfactory natural reproduction and rapid growth of desirable species. This will be a factor of importance in the national movement for the prevention of forest devastation.

Studies of existing forests to determine the rate of growth and yield of forest products which may be expected at different ages when the forests are properly managed have already furnished the basis for regulating the cut on a number of National Forests with a view to a perpetual yield of timber.

Investigations in Arizona and New Mexico which have been under way for a number of years have yielded conclusive evidence that satisfactory natural reproduction of western yellow pine, the species of chief commercial importance in that region, can be secured only at wide intervals, averaging probably about 20 years. The high value of such natural reproduction, when it does occur, requires that every reasonable safeguard be provided to protect it from injury. These facts have led to unavoidable reductions in the live stock grazed on certain National Forests in the Southwest, in order to reforest cut-over areas.

The investigation of the effect of forest cover on stream flow, which is being conducted at the Wagon Wheel Gap Experiment Station in Colorado, in cooperation with the Weather Bureau, has entered its most interesting phase as a result of the removal of the forest cover on one of two adjacent watersheds under observation. During the preceding eight years the behavior of the two streams at all times of the year and under all conditions was definitely established by systematic and continuous records.

As a result, it will be possible to predict what the flow of the stream from the denuded watershed would have been under practically any conditions if the forest cover had remained intact. During the second phase of the experiment the same observations will be continued, to determine what effect the removal of the forest cover will have on the flow of the stream coming from that watershed. Already a marked difference has been observed in the behavior of this stream in that the spring flood occurred much earlier and the water ran off more rapidly than would have been expected under undisturbed conditions.

In southern California, where the regulation of stream flow and prevention of erosion by forest cover are of the greatest importance to large areas of valuable irrigated lands, observations on water-

sheds severely burned in the fall of 1919 have shown more rapid run-off and greatly increased erosion resulting from the removal of the cover. In some cases several inches of surface soil was removed from the burned areas by heavy rains which caused little or no erosion in adjacent unburned watersheds. Check dams erected in the bed of one of the streams following the fire were completely filled with débris, and measurements of the peak discharge showed that detritus formed much the greater part of the run-off. Investigations of methods of reestablishing the cover and controlling erosion are being continued in cooperation with local interests.

The study in cooperation with the Office of Farm Management on the relation of woodland to the rest of the farm was practically completed and its relative importance in different regions and under varying conditions established. The value to the farmer of his woodland is often much greater than he realizes. With the rapidly diminishing supply of old-growth hardwoods, farm woodlands may assume much greater importance in the near future as a source of commercial hardwood supply.

Necessary forest research has been handicapped seriously by the reduction of 36 per cent in the appropriation for this purpose below that of the preceding year. Three experiment stations previously established in Colorado, Idaho, and Washington have had to be virtually closed and current studies in important eastern forest regions have had to be postponed or greatly restricted. To build up forestry practice in the United States adequately the four experiment stations in the West should be fully equipped and manned and additional stations should be established in New England, the Allegheny region, the southern Appalachians, the Southern Pine Belt, the Lake States, and California. Sufficient funds to make a definite start upon this program, as well as to maintain the economic and industrial investigations, would be no more than a wise public outlay for the perpetuation of one of our most essential natural resources.

#### FOREST ECONOMICS.

The steady depletion of our forest resources, coupled with the many problems presented by the changed conditions following the war, has accentuated the need for economic investigations relating to the forest and its products and led to increased work in this field. Emphasis was also given to this line of research by the passage in February of Senate resolution 311 requesting the Forest Service to furnish by June 1 such information as was available regarding timber depletion, lumber prices, lumber exports, and concentration of timber ownership. A number of other specific studies along economic lines were undertaken. One of the more important dealt with the pulp and paper industry. Since 1916 the prices of various kinds of paper have materially advanced, and in the fall of 1919 an unprecedented demand for newsprint brought the paper question prominently before the country. Various bills were introduced in Congress looking toward the relief of the publishers. A careful analysis of the situation by the Forest Service made it apparent that permanent relief can be secured only by increasing production and providing an adequate supply of raw material from which newsprint is manufactured.

Fundamentally the continuation of the newsprint industry, as of other wood-using industries, is dependent upon the practice of for-



estry. Immediately the need is to develop western sources of supply. This was made clear in a report on a bill introduced by Senator Poindexter authorizing the Secretary of Agriculture to make a survey of pulpwoods on the public domain and to prepare a plan for the reforestation of pulpwood lands. The report brought out that the use of newsprint paper has been increasing much more rapidly than the population while the supply of raw material in the regions where its manufacture is centered has been steadily decreasing. Approximately 95 per cent of the newsprint manufacturing industry is in New England, New York, and the Lake States. Large areas in these regions, once covered with pulp timber, have been cut over or burned over and are now producing but little, and the annual cut is several times greater than the growth of the forests. The industry has made but a meager development in the Pacific Northwest and none in Alaska, where our largest remaining timber supplies suitable for newsprint are located. Canadian supplies are no more inexhaustible than our own, and in the eastern provinces the industry is still expanding very rapidly. The United States can not permanently rely on obtaining increased supplies of pulpwood and newsprint from Canada, even if that should be regarded as desirable as a matter of public policy. An exhaustive survey of our pulpwood resources, as proposed by the Poindexter bill, is necessary and urgent.

Greatly increased attention was paid to keeping in touch with the situation and developments in the lumber industry. Current studies were made of market conditions, lumber production, stocks on hand, shipments, and price tendencies, as well as of labor and operating conditions, exports and imports, and transportation. The collection of lumber prices was conducted on a more systematic and comprehensive basis than before. In the case of southern yellow pine, current prices based on actual sales are now being obtained on an approximate annual cut of 10,000,000,000 board feet.

Statistical work connected with the production of forest products was continued. Figures covering the production of lumber, lath, and shingles, tight and slack cooperage, and wood pulp, and the consumption of pulpwood for the calendar year 1918 were secured and published. These statistics are the only authoritative ones of the kind collected and are widely used not only by the lumber and other wood-using industries, but by various Government organizations and the business world in general.

#### RANGE INVESTIGATIONS.

During the field seasons of 1917 and 1918, as a war measure, all available range experts were placed on a rough survey with a view to immediately increasing the stock carried on the National Forest ranges as far as possible. Beginning with the field season of 1919, intensive range reconnaissance to determine permanent carrying capacities was again undertaken: 1,935,530 acres were covered by special crews and 180,338 by local forest officers, bringing the total area of National Forest range thus covered to date up to 18,524,508 acres.

The experiments in the artificial reseeding of range with cultivated forage plants were continued in a limited way at the Great Basin Experiment Station and Jornada Range Reserve. They confirm the view that this method will be useful on a small, but important, percentage of the range where growth conditions are exceptionally favor-



able. Progress was made in determining where such reseeding can be done profitably and the proper season for it under certain conditions. Investigations in seeding and planting native species at the Great Basin and Fort Valley Experiment Stations have shown that good results can be obtained with hardy species grown under conditions similar to those on the area to be seeded.

The importance and value of the experiments in the natural reseeding and management of range were never more clearly demonstrated than in 1919. At the Jornada Range Reserve 1918 was the last of three years of drouth accompanied by progressive range deterioration. On many adjoining ranges, where excessive grazing continued, there was almost an extinction of forage plants. Within the reserve the vegetation, though depleted in density, was so vigorous as a result of the management practiced that the favorable climatic conditions in 1919 produced practically a normal crop of forage.

The management plan applied within the reserve brought the breeding herd through the drought with extremely light losses and good calf crops, as against heavy losses and low calf crops on outside ranges, and demonstrated that the raising of high-grade cattle on such lands can be made a stable industry instead of one subject to heavy periodic losses. This is of utmost importance to the live-stock industry of the Southwest.

Investigations at the Great Basin Experiment Station indicate the possibility of determining changes in the improvement or deterioration of ranges through comparatively slight changes in the plant composition. If this relationship holds true generally, it will afford a means of detecting damage at an early stage, when counter-measures will not materially affect the use of the range. The studies along this line will be continued and extended to other regions.

The study of the distribution, forage value, and life history of the plants which make up the forage crop on the National Forest ranges was continued. Several new species were collected and identified. In all about 39,500 specimens, representing about 5,200 species and varieties, have been collected and observed to determine their importance as forage components. Economic notes are now available for about 2,800 species of National Forest range plants. Nearly 4,000 specimens were added to the range plant herbarium in the Washington office.

The study of grazing on alpine lands subject to erosion and floods emphasized the necessity for care to avoid overgrazing such lands and for prompt adjustment of grazing, if erosion has set in, so that revegetation will take place.

Continued attention was given to improved methods of salting cattle to secure better distribution of stock and consequently better utilization of the range. By the construction of 66 salt troughs and the application of a properly arranged salting plan one cattle allotment on the Minam Forest, Oreg., now grazes approximately 2,200 head of cattle and horses as compared with 1,574 head in 1913. A cattle range on the Okanogan Forest, Wash., was increased in grazing capacity from 800 head in 1914 to 1,300 head in 1917 by the construction of 36 salt troughs, the development of a few springs, and building a few short drift fences; and the condition of both stock and

range was improved. Similar results, though not always so marked, are being widely secured on the National Forest cattle ranges.

At the Great Basin Experiment Station intensive investigations have shown that removal of the herbage of range forage plants four times in a season caused the yield to decline until at the end of the third year most of the plants had been killed. Where the herbage was removed but once or twice near maturity the yield increased with each year and was many times greater. The vigor and root systems of the plants were also markedly better.

On many ranges full utilization of the forage is possible only by grazing both cattle and sheep on the same range, but failure to adjust the ratio of cattle to sheep in accordance with the forage available may have undesirable consequences. This subject will receive further study.

The work of eradicating tall larkspur by grubbing was further extended. By the end of the fiscal year about 3,580 acres had been grubbed at an average cost of \$5.50 per acre, while 8,300 acres more, where the larkspur was present in small quantities, had been cleared at about 20 cents per acre. The total cost has been \$19,930, of which stockmen paid about one-half. The value of stock saved is estimated at over \$34,000 annually. Stockmen generally are willing to contribute 50 per cent or more of the cost of eradicating poison plants and in some cases are undertaking the eradication of their own accord.

#### MISCELLANEOUS.

Twenty-three new publications were issued. The distribution of Forest Service publications totaled 213,599 copies. About 111 addresses were made, mainly at expositions and upon request from National Forest users, lumbermen's associations and similar trade bodies, technical societies, and educational institutions. The distribution of lantern slides and traveling exhibits was extraordinarily effective this year, the number of persons reached being more than six times as large as the year before. Lantern slides were loaned to more than 417 persons engaged in educational work. These were shown 1,095 times and to 70,898 persons. Additions to the lantern slide collection totaled 1,627, and 101 bromide enlargements, 44 transparencies, and 2,263 lantern slides were colored. Traveling exhibits of photographs, maps, drawings, and wood samples were loaned to 241 schools and libraries. Through sales, loans, and gifts 4,650 individual photographic prints were made available for outside illustrative purposes.

More extensive use than ever before was made of the Forest Service library in Washington. Loans from it, more than two-thirds of which were periodicals, totaled 11,143, or an increase of nearly 28 per cent over the previous year. Additions to the library amounted to 705 books and pamphlets, bringing the total number on file at the end of the year to 21,619. Several bibliographies were prepared, the most extensive of which was one on Douglas fir, containing some 350 titles. Additions to the 162 field libraries of the Service brought to 31,878 the books and pamphlets recorded in the main library, besides numerous State and other publications not so recorded.

## REPORT OF THE CHEMIST.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF CHEMISTRY,  
*Washington, D. C., October 15, 1920.*

SIR: I submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1920.

Respectfully,

C. L. ALSBERG,  
*Chief of Bureau.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### REPORT OF WORK.

The struggle to maintain efficiency despite mounting operating costs, rapid turnover of the personnel, and reduction of the force through resignations, for which inadequate salaries alone are responsible, has been the main characteristic of the year's work. The average salary for chemists is \$2,275 per annum, the minimum \$1,200, and the maximum \$4,500. The average salary for food and drug inspectors is \$1,840, the minimum \$1,400, and the maximum \$2,500. In addition, all employees upon a salary of \$2,500 or less receive, by special act of Congress, a bonus of \$240 per annum.

On June 30, 1920, the staff of the bureau consisted of 593 persons, of whom 263 were chemists and technically trained men, 42 inspectors, 155 clerks, and 133 miscellaneous employees. During the year the bureau lost by resignation, transfer, or death 74 technically trained men, 12 inspectors, and 68 clerks. The total loss was 210 persons, which is 35 per cent of the present force, and does not take into account a considerable number of vacancies. Among those who resigned were the chief of the eastern food and drug inspection district; the chemist in charge of the color laboratory and his understudy; the chemist in charge of the food research laboratory; the chemist in charge of the office of State and municipal cooperation; the chiefs of the food and drug inspection stations at Denver and Baltimore; the chemist in charge of the plant chemical laboratory; the chief inspector for the central food and drug inspection district; the librarian; the executive in charge of the office of accounts and his understudy; and the secretary to the chief of the bureau. The chief of the New York station, one of the ablest and most respected chemists in the service, Albert F. Seeker, was lost by death.

In order to maintain the law enforcement work it has been necessary to reduce very materially the constructive research work of the bureau designed to promote efficiency in the food and drug industries and to develop new methods for the discovery and detection



of sophistication. This expedient has for the time being been successful so far as the apparent volume of work accomplished would seem to indicate, since the total number of cases recommended to the Solicitor for prosecution exceeded by 40 the total for last year, when a far larger number of cases was developed than in any previous year. Furthermore, the number of imports of food and drugs was unusually large, so that with the depleted staffs at the port laboratories of the bureau it was exceedingly difficult to examine all entries uniformly. The volume of this kind of work can not be regulated, nor can it be planned for in advance.

While, therefore, the enforcement of the food and drugs act during the year was probably quite as effective as in any preceding year, this favorable showing was the resultant of at least four factors: (1) Increased efficiency and experience; (2) the lag that exists in the recording of results (a large number of the cases developed in any year do not appear in these records until the succeeding year); (3) the use of research chemists for law-enforcement work, with a corresponding lessening of the bureau's efficiency in constructive research; (4) increasing the proportion of seizure actions as compared with criminal prosecutions over that which prevailed in former years. The amount of labor involved in developing a criminal prosecution is, as a rule, very much greater than that required to consummate a seizure.

The neglect of research, which has been unavoidable, will inevitably in time impair the effectiveness of the enforcement of the law, since the bureau is dependent upon research for the means to combat new types of sophistication which are constantly appearing as methods and materials change with the evolution of the food and drug industries. Finally, without its research work the bureau can not render to the general public, the farmer, and the food and drug manufacturer that consulting and advisory service concerning the chemistry and technology of foods and drugs, organic chemicals, agricultural chemistry, and a host of kindred subjects which the country has a right to expect. However, as the conduct of any individual research usually covers a period of years, the effect is not yet apparent in the bureau's research output as measured by the number of its publications during the year. The bureau put out 7 department bulletins, 4 circulars, and 1 farmers' bulletin. In addition, the results of more than 75 investigations were made public, while those of over 50 are now in press. The experimental work upon a number of others has been completed. At the beginning of the fiscal year 15 applications for public service patents were pending. Twelve additional applications were filed during the year; 6 were granted, 6 denied, and 15 are pending.

The total appropriation for the bureau was \$1,391,500, of which about \$50,000 remained unexpended and reverted into the Treasury. The latter sum represents in the main moneys allotted for salaries but unexpended because vacancies due to resignations could not be filled promptly or, indeed, in many cases, filled at all. Incidentally, it may be stated that for some time past there has not been a year when a portion of the bureau's appropriation has not remained unexpended. In 1918 it was as little as \$7,881.73, but in 1917 it was \$105,978.08

## ENFORCEMENT OF THE FOOD AND DRUGS ACT.

## DOMESTIC FOODS AND DRUGS.

Fourteen hundred and seven recommendations for seizure and 851 recommendations for criminal prosecution were made to the Department of Justice, through the office of the Solicitor. Table 1 gives a list of the classes of products on which action was recommended, and also the distribution of the recommendations among the various types of products.

TABLE 1.—*Recommendations of actions on alleged violations of the Food and Drugs Act transmitted to the Solicitor.*

Article.	Criminal actions.	Seizures.	Article.	Criminal actions.	Seizures.
Alimentary pastes.....	3	5	Gelatin.....	20	4
Beverages and beverage ingredients.....	20	6	Ice-cream cones.....		3
Candy.....	2	1	Jam, jelly, and marmalade.....	6	4
Cereals.....	1	4	Meat and poultry.....	2	
Chocolate and cocoa.....		15	Nuts.....		2
Coffee substitutes.....	3		Olives.....		3
Colors, food.....	2		Oils, olive, table, salad, etc.....	125	17
Dairy products.....	12	24	Pie fillings.....	3	
Drugs, crude.....	4	1	Poppy seed.....		2
Drugs, pharmaceutical.....	7		Preservatives.....	1	
Drugs, various remedies.....	77	606	Saccharin.....	5	8
Drugs, remedies for stock.....	9	79	Shellfish.....	80	
Drugs, venereal disease remedies.....	3	215	Sirups, honey, sugar.....	1	5
Eggs.....	45	16	Spices and relishes.....	7	1
Egg substitutes.....	17	8	Tomato and tomato products.....	6	84
Feeds.....	242	36	Vegetables.....	18	83
Fish.....	11	67	Vinegar.....	17	28
Flavoring materials.....	30	28	Water, mineral.....	29	8
Fruits.....	10	44	Total.....	818	1,407

Examination of Table 1 shows that prosecution was recommended most frequently on shipments of patent medicines, of mineral waters, of stock feeds, of edible oils, of flavoring materials, of beverages, of eggs and egg substitutes, of dairy products, of fruit and vegetable products, of gelatin, of fish and shellfish, and of saccharin.

The distinctive characteristic of the year's work on drugs was the systematic campaign, begun last year, against misbranded medicines for the treatment of venereal diseases, and continued with such success that misleading statements upon the packages and labels of these preparations have almost wholly disappeared so far as interstate commerce is concerned. With the assistance of the Bureau of Animal Industry, many successful actions were brought against misbranded veterinary remedies, especially against those claiming to cure or prevent hog cholera.

Some of the cases against shipments of fruits were directed against rain-damaged raisins of the California crop of 1918 that were so moist as to have become moldy or that were contaminated with enough unremovable sand spattered upon them by the rain to render them inedible. Vigorous action was taken in cooperation with the California authorities to prevent the shipment of evaporated apples with excessive moisture. Thousands of tons had to be adequately dried, with a corresponding saving to the consumer. In consequence, moisture content has been included in the trade's in-

spection and a chemist is now in the employ of the industry to see that in future the consumer gets apples, and not water at the price of apples. While hereafter the public will be saved annually some thousands of dollars, the total cost to the bureau of this work over and above salaries was approximately \$225.

A number of other fruit products, especially vinegar and beverages, such as misbranded or adulterated cider, or imitations sold as genuine fruit beverages, required prosecution. Among the latter, imitation orange-juice beverages were particularly prominent. Machines known as homogenizers or emulsors, designed to subdivide oils or similar liquids so finely in water or other liquid immiscible with the oil as to produce permanent emulsions, have been in use for a variety of purposes for a number of years. These are now employed in the soft-drink industry to emulsify such oils as orange oil in manufacturing a cloudy, strongly-flavored beverage. Because these beverages are cloudy, they are easily palmed off as containing fruit juice. As orange juice is used not merely as a beverage, but also in infant feeding, such a deception may have serious consequences. It is therefore important to see that these drinks are branded in such manner as to give the customer full information of their true character. Sold under such conditions, they are legitimate products. Announcement was made last year of the discovery of a new method for the identification of waste apple products vinegar. With the help of this method seizures of such vinegar sold as genuine cider vinegar were made this year and are now awaiting judicial determination.

Despite the fact that between one-seventh and one-eighth of all the cases brought under the terms of the food and drugs act are against feeds, flagrant abuses still persist. Whenever there is a rising market for such products as cottonseed meal, as was the case last year, violations of the law become quite frequent. For a number of reasons the bureau can not avoid paying an amount of attention to feeds out of all proportion to that paid to foods and drugs. Nevertheless, the situation is quite out of hand, and more drastic action by special appropriation, so that there may be enforcement of the law with reference to feeds without sacrificing the efficiency of the control of human foods, is called for.

A typical example of the value of the food and drugs act to purchasers of stock feed is to be seen in the case of the bureau's experience with the substitution of bran for shorts during the year. Throughout 1919 the difference in price between bran and shorts ranged from \$14 to \$22 per ton. For many months, from July to October, this difference ranged from \$17 to \$19 per ton. During the same period red dog flour was quoted at a price very close to that of shorts, usually from \$2 to \$5 per ton higher. Few sales, however, were made, a large part of the red dog flour being mixed with and sold as shorts. Because of the unusual demand of the feeders for hog feed, the price of shorts, which is ordinarily less than that of bran, became so high as to induce many individuals to grind bran finely and to substitute it for and sell it as shorts. In this case the buyer, almost always a stock feeder, was defrauded of at least \$18 per ton. This substitution of reground bran for shorts was very common during the latter half of 1919 and the early part of 1920. Action was



taken on the product of 12 mills located at various places from the Atlantic to the Pacific, and from North Dakota to the Ohio River. Each of these 12 mills had an output of from 4 to 12 and more cars weekly, a carload ranging from 25 to 30 tons. If it be assumed that 12 mills have a weekly output of eight 25-ton cars each, that the illegitimate profit amounts to \$18 per ton, and that the fraudulent transactions lasted for but 16 weeks, the total fraud upon the purchaser of this kind of feed from these mills alone was in excess of \$690,000. The action which the bureau was able to take has reduced this fraud to practically nil, and it is therefore safe to assume that the sum of money which was saved the feeders of the United States is of the same order of magnitude as the entire annual appropriation of the Bureau of Chemistry.

The work dealing with the use of rice hulls as an adulterant, reported upon last year, was continued, as was also the investigation of alleged abuses in the sale of peanut by-product feeds and alfalfa feeds. Furthermore, an investigation of the adulteration of feed molasses with water was begun.

Butter containing less than 80 per cent of butter fat or more than 16 per cent of water, or both, was the chief dairy product proceeded against. Moreover, the efforts that have been made for years past to improve the milk supply of St. Louis, Mo., reached a culmination this year. Years ago deplorable conditions were encountered at St. Louis. Instances of violation of the food and drugs act had been detected there and successful prosecutions instituted. Such prosecutions had little or no effect in bringing about a general betterment of the St. Louis milk supply. While it is clearly recognized that the duty of safeguarding a city's milk supply is a municipal function, this principally because the city health department is the only agency in a position to maintain that constant supervision which is essential, still this bureau could not ignore the conditions in St. Louis, where violations of the food and drugs act were flagrant, more especially as there were recurring from time to time milk-borne typhoid epidemics, with consequent sacrifice of life. Accordingly there has been carried on over a period of several years an intensive study of the existing conditions and contributing causes, with experimentation to determine the essential elements necessary for clean milk production. Milk going for the St. Louis supply was found to be largely watered, skimmed, filthy, and containing excessive numbers of bacteria. It was determined that sterilization of utensils, care, and cleanly methods of production will in that locality, as elsewhere, produce milk with few bacteria. It was further found that unclean milk cans were the chief contributors of bacteria to milk shipped to the St. Louis market. An educational campaign was undertaken some years ago. All of the facts with respect to conditions and causes were laid before producers, distributors, and city health authorities in St. Louis and a constructive program for correction was outlined.

Subsequent investigation indicated no appreciable improvement, whereupon specific violations of the food and drugs act were brought to the attention of the Federal grand jury in St. Louis, resulting in indictments against 20 producers and buyer-shippers on multiple counts. This was the culmination of the work of a number of years, and during the current year pleas of *nolo contendere* have been en-

tered by most of the defendants in these cases, the result being, as anticipated, that the public has been advised by consequent publicity of the dangerous condition of its milk supply and has been brought to realize the urgent necessity for a strong municipal control thereof.

The cases against shipments of fish involved for the most part canned salmon which contained some fish that were decomposed before they were canned. This project, begun in the spring of 1919, occupied the attention of the regulatory force of the bureau to a greater extent than any other. Much of the salmon involved had at one time or another been in the possession of the Army. All parcels that proved objectionable were permitted to be distributed only after the packers had eliminated the objectionable portions. To accomplish this the top of each can was cut off by a specially constructed machine so as to permit thorough examination of the contents. All doubtful salmon was sent to the dump or the fertilizer factory, or was used as fish food at hatcheries. Such good salmon as remained was recanned or resealed with new tops, resterilized, and then re-examined by the bureau's agents.

Action was also taken against shipments of canned "blue-fin tuna," "striped tuna," and bonita labeled to create the impression that the cans contained the "white meat," which is obtained from a different species. These cases are awaiting judicial determination.

The cases against shellfish involved the charge of adulteration with water. Announcement was made of the weights which are representative of properly filled cans of minced razor clams and minced hardshell clams.

The project which occupied the bureau more than any other except the salmon work was the inspection of ripe olives for the purpose of removing from the channels of trade those that were spoiled and might therefore harbor the *Bacillus botulinus*, a micro-organism producing a virulent toxin. Two lots containing this organism were located and promptly seized. No cases are on record of poisoning by green olives in brine, so-called "Queen" olives. As it was quite impossible, with the bureau's limited force, to locate and inspect the hundreds of small lots of olives scattered about the whole country on grocers' shelves, the cooperation of State and municipal officials was enlisted to inspect and prevent distribution of any lots which were in the least degree suspicious. At the same time the attempt was made to induce the packers to have all olives sterilized at low temperatures returned to their plants in California for the purpose of removing all that showed evidence of decomposition and of resterilizing the rest at high temperatures. Most of the packers cooperated. With the cooperation, therefore, of State and municipal officials and of the trade itself it was possible to afford the public a degree of protection that the limited personnel of the bureau and the limitations of the law itself would not have permitted. Since that time the industry, in cooperation with the State authorities of California, has employed competent scientists, and is taking such action as will render a recurrence of fatalities extremely unlikely.

The high price of sugar led to an increase in the use of saccharin which was quite extensive in certain localities, but much less extensive in interstate commerce. Action was taken against foodstuffs containing saccharin, notably various sirups, as well as so-called con-

centrated sweeteners consisting of saccharin and sugar or some other diluent. These cases are awaiting judicial determination. During December a case alleging misbranding of saccharin labeled as "the perfect sweetener," "healthful," and "absolutely harmless" was tried in St. Louis. The jury disagreed.

The cases against shipments of flavoring materials, mineral waters, eggs, oils, gelatin, and tomato products involved charges similar to those reported in former years.

The work upon egg substitutes has largely reduced the number in the channels of trade. None of those examined were found to be real substitutes for eggs, either in food value or in their effect in baking.

The numerous cases against shipments of vegetables resulted from the substitution in canning of the cheaper, wholesome, nutritious long cranberry bean, also known as Naga Uzura bean, for the more expensive red kidney bean. These cases are still awaiting judicial determination.

Over 1,000 of all the shipments sampled during the year required a consideration of some phase of that section of the law which demands the declaration on the outside of the package of the true quantity of food contained therein. Of these, 41 per cent went to the Solicitor for prosecution; 60 per cent of the prosecution cases bore a charge of short weight and 40 per cent a charge of non-declaration of the quantity of the contents. Eighty per cent of the cases recommended for prosecution bore additional charges for a violation of some other section of the law. Eighty-five different products were involved. One-tenth of all cases involved feeds and one-sixth fruits and vegetables, the charges against these products being principally for non-declaration. One-sixth of all samples were canned viscous liquids, such as olive oil and molasses. Moreover, olive oil, bottled goods, and butter were often short in weight or volume.

The education of shippers in the requirements of the net-weight amendment of the food and drugs act was carried on as in former years. In Texas, for example, the shippers believed their packages complied with the law because they had been inspected and passed by the inspectors of the State Bureau of Markets. Circulars were distributed, information published in the local trade papers, association meetings attended, and cooperative relations established with the State Bureau of Markets of Texas in order to give publicity to the requirements of the Federal law. In consequence recent shipments of fruits and vegetables from this section of the country are marked with the quantity of the contents of the packages. The bureau has enjoyed the fullest cooperation of State and city sealers of weights and measures, who have tested scales, investigated complaints, and planned and carried out special campaigns.

A review of the work of the last five years in the enforcement of the net-contents-declaration provision of the food and drugs act shows a steadily increasing number of prosecutions, due not to an increasing failure on the part of the shippers to comply with the law but to increasing knowledge on the part of enforcing officials obtained through the bureau's investigations of shrinkage and of processes of packaging. A report on some of these investigations, Department Bulletin 897, Weight Variation of Package Foods, was



prepared for publication. Of all notices of judgment published during the past five years, 307, or 9.2 per cent, contain reference to violations of the net-weight amendment. Of these 307 cases, 19 per cent contain no other charge than violation of the net-weight amendment. Sixty-two per cent contain a charge of shortage in weight or volume. The average shortage in those cases prosecuted for that reason solely was 10.8 per cent. One hundred and twenty-five seizures in which net-weight violations were involved were made during the period. The products against which most of these notices of judgment have been published are, in order: Olive oil, cottonseed meal, mineral water, tomato pulp, and evaporated apples.

The net-weight provision of the law was amended so as to bring hams, sides of bacon, and similar meat products, when wrapped, within its provisions. The language of this amendment is as follows:

[Public, No. 22, 66th Cong., H. R. 7413.]

AN ACT Making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1920.

That the word "package" where it occurs the second and last time in the act entitled "An act to amend section 8 of an act entitled 'An act for preventing the manufacture, sale, or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and for regulating traffic therein, and for other purposes,'" approved March 3, 1913, shall include and shall be construed to include wrapped meats inclosed in papers or other materials as prepared by the manufacturers thereof for sale.

In order to prevent the slack filling of canned fruits and vegetables, the bureau has made an extensive investigation of the commercial methods of canning employed in the case of some 30 of the more common fruits and vegetables for the purpose of determining what is the greatest amount of solid material, exclusive of liquid, which can be packed in cans of various sizes without causing any impairment of quality. Following this investigation the bureau addressed circular letters to commercial canners throughout the United States, specifying definite amounts of solid material, exclusive of liquid, which should be present in cans of various sizes. The letters issued during the year referred to spinach, Swiss chard, beet tops, Lima beans, pears, pitted cherries, and sauerkraut. Announcements supplementing previous ones were issued on wax and refugee beans, peaches, and green peas. A very extensive inspection campaign has been carried on for the purpose of securing observance of the opinions expressed in these circular letters. As a result of this campaign, the practice of packing cans with an excessive amount of liquid and a deficient amount of fruits or vegetables, which was formerly followed by many canners, has been very largely discontinued. The results obtained are of great economic importance from the standpoint of the consumer, inasmuch as great fraud, which the consumer has been unable to detect prior to purchase and opening of the cans, has been practiced in connection with the slack filling of cans of certain fruits and vegetables.

During the past year the courts have rendered several decisions containing important interpretations of the law:

The decision referred to in Notice of Judgment 7691 concerned the adulteration of oil of sweet birch and oil of wintergreen with synthetic methyl salicylate. Seizure of the goods had been made under

the law and the claimants requested release under bond for relabeling. The court held that the release as requested was not mandatory but discretionary with the court. The goods were accordingly not released under bond but were ordered forfeited to the Government.

The Circuit Court of Appeals for the Fifth Circuit has rendered an important decision in connection with the Sherley amendment. In the construction to be applied to a label for mineral water which is recommended for the treatment of various diseases, the court held that a statement recommending the water for the treatment of various diseases meant that the water was an alleviation or cure for the diseases mentioned, and the contention that the water condemned was not a drug was not tenable after the water had been put in interstate commerce with the recommendation that it possessed certain elements or ingredients which were claimed to be curative or at least to alleviate the diseases named in the label.

In a case involving an article labeled as a substitute for eggs, the contention was made by the defendant that the representation on the label was not one of fact but of opinion only and therefore not in law misleading. The court held that as the defendant had chosen its own definition for the term "substitute," when it stated upon the label that the article could be used in place of eggs in baking and cooking, the only inference that could be drawn was that the article would produce the same or similar results as eggs. Accordingly it was held that the allegations of the information that such statements were false and misleading clearly brought the statements within the category of the law.

In a number of judicial districts some difficulty has been encountered in filing libels under section 10 of the act for the seizure of food and drug products shipped in violation of the act. This difficulty arises in part from the practice of a number of jurisdictions which require that the libel can not be filed until first signed by the judge. The illness of the judge or his absence from the jurisdiction in such cases sometimes causes a delay in the seizure of goods adulterated or misbranded under the act and their consequent escape from the penalty of the law. One judge has recently refused to sign the libels unless they are supported by a chemist's affidavit, his position being that to do otherwise would be a violation of the fourth amendment.

The service and regulatory announcements published during the year contained 36 opinions and 600 notices of judgment. While there is evidence that the courts are again tending to impose severer penalties for violations of the food and drugs act, the publicity given through the court proceedings and the notices of judgment is still the principal penalty. Indeed, these notices give the most reliable history of the development of the courts' interpretation of the law, as well as of the department's policies with reference thereto. Unfortunately, these notices are not sufficiently studied by manufacturers. If they were, infractions of the law could and no doubt would be avoided by them.

A new edition of the Food and Drug Manual, containing the procedure and instructions to be followed by the bureau's inspectors and by collaborating officials, was issued for the sole use of these officials.

A directory of Federal and State dairy, food, drug, and feeding stuffs officials was also published.

Cooperation with State and municipal officials has been growing rapidly. Statistical data fail to show the extent to which the field force of the bureau is cooperating with, as well as assisting and being assisted by, the various State and city agencies. Such statistics as are available will be found in Table 2, giving the cases instituted by State agencies, and in Table 3, giving the cases instituted by city agencies. It will be seen that during the year 333 such cases were instituted by these agencies, 120 more than in any previous year. In addition there was, of course, an interchange of a vast amount of information either by direct personal communication with the bureau's agents in the field or by correspondence with the bureau or through the bureau's monthly review, the character of which has been somewhat changed by the elimination of a great deal of detailed information, with the understanding on the part of cooperating officials that such information may be secured by correspondence on request. The tables, moreover, do not indicate the large amount of work in connection with those cases that did not go to prosecution or to seizure. One hundred and fifty-nine samples of this kind were analyzed by collaborating officials, and, in addition, a large number of which the bureau has no record that were found to require no further action.

TABLE 2.—*Number of actions instituted by State officials alleging violations of the Federal food and drugs act.*

States.	Prosecutions.			Seizures.		
	Food.	Feed.	Drug.	Food.	Feed.	Drug.
Alabama.....				1		
Arizona.....				1		
Arkansas.....	2				1	
Florida.....	8	1			3	
Georgia.....	2	2		1		
Illinois.....				6	2	
Indiana.....		11		3	2	
Iowa.....	2	4		1	2	
Kansas.....		7		2	11	
Kentucky.....		4				
Louisiana.....	2					
Maine.....		4			1	44
Michigan.....	1	9	1	2	4	1
Minnesota.....	1					
Mississippi.....		3				
Missouri.....				1		
Nebraska.....	1			2		
Nevada.....				1		
New Hampshire.....						6
New York.....	1					
North Carolina.....		1				
Ohio.....	3	1		37	1	3
Rhode Island.....	1					
South Dakota.....	1					
Tennessee.....					1	
Texas.....		2		4		4
Utah.....				4		
Vermont.....						15
Virginia.....		2				
Washington.....	1			2		
Wisconsin.....		2		3		
Wyoming.....	1			2		
Total.....	27	53	1	73	28	73



TABLE 3.—*Number of actions instituted by municipal officials alleging violation of the Federal food and drugs act.*

Cities.	Prosecutions.			Seizures.		
	Food.	Feed.	Drug.	Food.	Feed.	Drug.
Lexington, Ky.....				1		
Cleveland, Ohio.....	1	1		8		4
Memphis, Tenn.....						3
Salt Lake City, Utah.....				1		
Washington, D. C.....	57		2			
Total.....	58	1	2	10		7

During the year 273,540 pounds of straight dyes were certified. Of this amount 138,395 pounds consisted of straight dyes certified under foundation certificates. The relative quantities of the straight dyes certified, exclusive of repacked colors, were as follows:

Amaranth, 43.3 per cent; Tartrazine, 17.7 per cent; Ponceau 3 R, 16.6 per cent; Orange I, 12.7 per cent; Yellow A B, 4.1 per cent; Indigo Disulpho Acid, 2.9 per cent; Naphthol Yellow S, 1.4 per cent; Erythrosine, 1.3 per cent; Yellow O B, 0.006 per cent; Light Green S. F. Yellowish, none.

#### IMPORTED FOODS AND DRUGS.

During the year the variety and quantity of foods and drugs offered for entry into this country have greatly increased, though there is little that is new or needs special mention. The number of samples taken and examined, particularly at the larger ports of entry, has very nearly, if not quite, equaled the number taken in any year previous to the World War. In other words, during this year, in so far as variety and sources of supply are concerned, importation of foods and drugs has rapidly approached a normal status, a condition contributing very greatly to the difficulties of administration due to the bureau's depleted force and funds.

It might be noted that jams have been imported from Australia, and that the amount of butter imported has been much above that coming to this country in most previous years. It has come principally from Canada, but also from Denmark, Holland, and Argentina, and in small amounts from other countries. Returned shipments of American butter have also been received. Some shipments of butter on examination were found to be adulterated in that they contained too little butter fat or too much water. Such shipments have been refused entry, except that, when reworking would produce a satisfactory product, release has been granted for reworking if conditions could be maintained which would leave no question as to the identity of the goods, and the finished product on examination has been found satisfactory.

During the year many varieties of foreign mineral waters have been offered for entry, even some which have not previously come to the bureau's attention. This is in contrast with the last few years, during which both the number of varieties and the amounts imported

have been very small. The percentage of shipments refused entry as adulterated because of pollution due to careless bottling or to contamination of the sources of the supply has been rather high. Relabeling has been required in some instances to eliminate exaggerated and unwarranted statements as to curative or therapeutic effect. Goods labeled as radioactive have revealed on examination little or nothing to justify such labeling.

Among adulterated drugs might be mentioned an ingeniously sophisticated shipment of so-called saffron, consisting of the dyed and weighted flowers of a plant unrelated to saffron and without either tinctorial or flavoring value. Quite a number of shipments of anise seed have been found to be adulterated with exhausted seed from which the volatile oil had been extracted, one shipment containing as much as 65 per cent of this worthless product. A number of shipments have been examined of Levant wormseed, *santonica*, which is gathered in the deserts of Turkestan and is the source of *santonin*, a valuable drug, the importation of which had practically stopped. Many of them, however, were found almost totally deficient in *santonin* and were refused entry.

Shipments of crude drugs deficient in active principles have been allowed entry for legitimate manufacturing purposes only, under conditions more fully outlined in last year's report. Many medicinal preparations bearing statements of therapeutic or curative effect have been relabeled more nearly in accord with the limits of usefulness of the ingredients.

Among the crude drugs which have been substituted for well-known drugs or for the official species noted this year not mentioned in the report of the Chemist in former years are the following: *Piper ribesoides* Wall. for the official cubeb, *Piper cubeba* L.; *Berberis*, sp. for Columbo root, *Jateorhiza palmata* (Lamarck) Miers; *Richardsonia pilosa*, H. B. K. for ipecac, *Cephaelis ipecacuanha*, Rich.; Indian valerian, *Valeriana wallichii*, D. C., and Mexican valerian, *Valeriana mexicana*, D. C., or related species for valerian, *Valeriana officinalis*, L. A shipment of Cocillana, N. F., *Guarea rusbyi* (Britton) Rusby, was invoiced as quinine bark.

Table 4 gives the distribution of the official samples examined by the various field stations. It does not include samples of thousands of shipments examined in a preliminary way.

TABLE 4.—*Report of field stations for year ended June 30, 1920.*

Laboratory.	Import samples.			Interstate sam- ples.			Mis- cella- neous.	Total sam- ples.	Hearings.	
	Leg- al.	Ille- gal.	Floor in- spec- tion sam- ples.	Leg- al.	Ille- gal.	Check anal- ysis.			Im- ports.	Do- mes- tic.
Central district:										
Chicago.....	198	140	842	170	567	91	560	1,726	126	262
Cincinnati.....	118	13	44	75	294	24	289	813	9	195
Minneapolis.....	89	14	133	17	145	16	184	465	3	164
New Orleans.....	21	37	83	27	124	18	291	518	22	194
St. Louis.....	43	8	31	97	361	47	565	1,121	11	282
Kansas City.....	11			41	31	2	23	108	1	145
Total.....	480	212	1,133	427	1,522	198	1,912	4,751	172	1,242
Eastern district:										
Baltimore.....	103	22	42	202	373	6	908	1,614	12	143
Boston.....	572	237	9,980	60	399	3	353	1,624	182	118
Buffalo.....	209	689	358	11	61	2	289	1,241	629	116
New York.....	2,401	2,806	22,707	221	317	22	1,172	6,939	1,592	340
Philadelphia.....	120	152	1,015	60	168	2	256	758	139	46
Porto Rico.....	138	463	1,491		60		276	937	461	
Savannah.....	60	16	25	63	268	15	206	628		155
Total.....	3,603	4,385	35,618	617	1,646	50	3,440	13,741	3,015	918
Western district:										
Denver.....	5	7	251	37	84		211	344		37
San Francisco.....	472	474	37,013	71	460	26	1,144	2,647	447	45
Seattle.....	229	113	9,400	44	79		696	1,161	96	19
Total.....	706	594	46,664	152	623	26	2,051	4,152	543	101
Grand total.....	4,789	5,191	83,415	1,196	3,791	274	7,403	22,644	3,730	2,261

## SUGARS, SUGAR DERIVATIVES, SIRUP.

The carbohydrate laboratory, which last year became disorganized, owing to the resignation of its director and practically the entire staff, has been reorganized under new leadership and has resumed active cooperation with the industry upon the production and refining of sugar and of sugar sirups. Directions will be issued before the coming crushing season for the production, by means of the yeast enzyme, invertase, of cane sirup that will neither crystallize nor ferment readily. Invertase will be furnished those desiring to try out the method and personal assistance will be given to as many producers as possible in the sirup-producing section.

The work upon the possible use of commercial maltose sirups in candy manufacture has been practically completed. A survey has been made of many of these sirups upon the market for the purpose of developing procedures for their analysis and for other reasons.

The attempt was made to discover substitutes for cane sugar in the canning of fruits and vegetables. Neither glucose nor maltose was found satisfactory because of their influence upon color and flavor. It was, however, possible to use some samples of refiners' sirup in the production of certain canned products.

The sweet potato, it has been discovered, contains enough of the enzyme, diastase, to convert all of its own starch into sugar and dextrin. Hence it would seem possible to make sirup commercially from sweet potatoes, and work looking to this end is in progress.



In extending the work upon the utilization of corn cobs, described in the report for the fiscal year 1918-19, it has been found that the valuable aldehyde, furfural, may be obtained from this material in commercial quantities. The data have been published.

The work of the bureau upon the production of rare sugars having been an important factor in establishing their manufacture commercially in the United States, in future the work will be limited to the production of such rare sugars as can not be obtained commercially. During the year a wide variety of pure rare sugars was furnished to various investigators for research purposes. Progress has been made in the development of a method for producing the rare sugar sorbose. New directions for the preparation of rhamnose and of levulose have been made ready for publication.

Papers have been printed upon the amide of  $\alpha$ -*D*-mannoheptonic acid, upon the rotatory powers of the amides of several  $\alpha$ -hydroxy acids of the sugar group, upon the occurrence of melezitose in honey, upon the crystallography of melezitose, upon the heptoses from gulose and some of their derivatives, and upon the acid fermentation of xylose.

Papers upon crystalline chlorotetracetyl fructose and related derivatives, upon the isomeric hexacetates of  $\alpha$ -*D*-mannoheptose, upon sedoheptose, a new sugar from *Sedum spectabile*, upon volemite, upon cellulose phthalate, and upon the optical properties of a series of heptitols are in press.

#### FATS AND OILS.

For the first time the nature and proportions of the fatty acids found in cottonseed oil were determined and published. Myristic, stearic, arachidic, and oleic acids were found. Myristic acid had not previously been found in cottonseed oil, and it had not been determined whether stearic or arachidic acid or both were present. In cooperation with the Society of Cotton Products Analysts, it was established that the locality in which cotton seed is produced has but the slightest influence upon the composition of the oil obtained from that seed. The physical and chemical constants of a large number of authentic oils from all parts of the country were determined and were found surprisingly uniform. Undoubtedly some other factor, probably faulty sampling, is responsible for the contrary statements reported in the literature. The bureau's publication on the subject will undoubtedly finally settle this controverted point.

A supplement to Department Bulletin 769, The Production and Conservation of Fats and Oils in the United States, revising the statistics of this industry up to January, 1919, has been issued. Papers have been printed upon the composition of tomato seed, Hubbard squash seed, okra seed, and hollyhock seed oils, and upon Chinese colza, a valuable oil seed not well known in this country. The oils from okra and hollyhock both give the Halphen reaction, hitherto regarded as characteristic of cottonseed oil. Okra, hollyhock, and cotton belong to the same plant family, the Malvaceae. The methods of preparing the menthol and phenyl-hydrazine derivatives of the higher fatty acids, as well as the properties of these compounds.

were studied in the hope, which proved illusory, that the properties of the individual derivatives would differ to such an extent from one another as to make it easier to separate the derivatives from one another than the parent acids. A report upon the results is in press.

Comparative analyses of a large number of samples of classified grades and kinds of unscoured wool have been published in a news letter and in trade journals. These analyses show the percentage of grease, ash, water-soluble matter, potash, and nitrogen in foreign as well as domestic wools. Improvements in the solvent process of extracting grease from wool and in the bleaching of wool grease have been developed in the laboratory and are soon to be tried out on an industrial scale in cooperation with a large wool scouring and spinning establishment.

#### CHEMISTRY AND NUTRITIVE VALUES OF PROTEINS.

The results of some of the studies on the chemistry of proteins have been published under the following titles: The Hydrolysis of Stizolobin, the Globulin of the Chinese Velvet Bean, *Stizolobium niveum*; Some Proteins from the Georgia Velvet Bean, *Stizolobium deerin-gianum*; Distribution of the Basic Nitrogen in Phaseolin. Papers are in press upon the determination of the jellying power of gelatins and glues by the polariscope, upon the preparation and properties of ash-free gelatins, and upon the acidity of ash-free and commercial gelatins. Work is in progress upon the hydrolysis of coconut globulin, upon the protein of the mung bean, of tomato seed press cake, of the Lima bean, and of the cohune nut.

The work upon the nutritive value of beans, especially of the genus *Phaseolus*, of cow peas and of the Chinese and Georgia velvet beans has been progressing favorably. The results obtained with the navy bean, showing that it can not support growth without the addition of cystine to the diet when the navy bean is the sole source of protein, have been published under the title *The Rôle of Cystine in Nutrition as Exemplified by Nutrition Experiments with the Proteins of the Navy Bean, Phaseolus vulgaris*. Similar studies are in progress on the adzuki, Lima, and mung beans. All of them, except possibly the mung bean, appear to be lacking in cystine. It has not been possible, hitherto, to obtain any growth on either the ground velvet bean or the raw isolated velvet-bean protein. Partial growth has, however, been obtained on the coagulated protein, which would seem to indicate that possibly failure to obtain growth in these cases may be due to some kind of toxicity. However, this will require further careful investigation.

The results of the investigations upon commercial corn gluten meal and upon the nutritive value of peanut flour as a supplement to wheat flour have been made public. An investigation upon the nutritive value of soy-bean flour as a supplement to wheat flour has been completed.

#### SEA FOODS.

New laboratories have been established at San Diego, Calif., and at Pensacola, Fla. At the San Diego laboratory special attention will be paid to the best methods of canning and preserving Pacific coast fish, particularly those of the tuna and sardine types. The

possibility of utilizing by-products that are now wasted or that may be utilized in some more satisfactory manner will also be examined. At Pensacola particular attention will be paid to the study of the composition and food value of Gulf fishes and to the best methods of preparing them for transportation and handling them in their passage to the consumer. Studies have been made upon the possibilities of canning frozen fish, and preliminary results seem to indicate that under proper precautions this may prove to be feasible.

Papers have been published under the titles *A Chemical Study of Frozen Fish in Storage for Short and Long Periods* and *The Food of the Small Sea Herring and Ammonia and Amines as End Products of Its Decomposition*. Department Bulletin 908, *The Maine Sardine Industry*, which embodies the results of a number of years' work, is in press. The chemical study of the variation of the food value of shad at different times has been completed.

In general, the studies upon the handling, cold storage, and transportation of fresh fish, described in some detail in the report of the Chemist for 1919, have been continued this year and are producing improvements in the industry. The studies begun last year in connection with the spoilage and the flora of fish, particularly of Pacific salmon, have been continued and are described in this report in connection with the general discussion of the bureau's work on food flora, spoilage, and fermentation.

A study of the trade waste effluents on the York River, which was made in cooperation with the Bureau of Fisheries, has been completed, and a report of the work, embracing the conclusions reached in regard to the relation of the effluents from the paper and pulp mills at West Point, Va., to the quality of the oysters, has been submitted to the Chief of the Bureau of Fisheries. A report was made to that bureau upon the sewage-disposal effluents at Bridgeport Harbor, Conn. Jointly with the Bureau of Fisheries, conferences were held with the Bridgeport officials and manufacturers. Steps to eliminate the objectionable conditions in that harbor are contemplated by the officials.

## POULTRY AND EGGS.

Department Bulletin 846, *Examination of Frozen Egg Products and Interpretation of Results*, has been issued. It gives directions for the chemical and bacteriological examination of frozen eggs and also outlines the manner of interpreting results. This work will enable the bureau to operate more efficiently in preventing inedible eggs from finding their way into frozen liquid eggs for bakers' use. Department Circulars 52, 55, and 74 were issued under the titles *How to Wrap Heads*, *How to Load Cars of Eggs*, and *How to Break Eggs for Freezing*, respectively.

During the year a number of shippers have consulted the laboratory regarding construction of chill rooms and poultry and egg-packing establishments. Either typical or special plans have been furnished. Several of the plans involved a cost of \$50,000 for construction. When this work was begun in Indiana in 1914 there was not a single chill room in that State. At the present time there are more than 20 such rooms and there are proportionately equal num-



bers in other poultry-producing sections. Three large railroads have sought advice and information concerning the details of construction of refrigerator cars for their lines.

Meetings were held in 16 cities with representatives of various railroads, the Railroad Administration, and Freight-Inspection Bureau. Models were used to illustrate the different types of loads as embodied in the new freight specifications for eggs; also correct methods for the use of fillers and flats in and for the proper construction of cases were demonstrated. The work with the shippers and producers which had been carried on for a number of years was continued, especially in the South where it is now needed.

As a preliminary to a general investigation of the causes entering into the absorption of foreign odors and flavors by eggs during cold storage, experiments were performed on the relative efficiency of various methods of treating eggs to seal the pores. The effects of such treatment have been studied with special reference to the loss of weight of the eggs in storage and to the degree of resistance of the eggs to bacterial invasions that cause spoilage.

The work on the most economical methods for the fleshing of poultry has been transferred from the laboratory to poultry-packing plants in the Middle West. It was demonstrated that the rations which were found most efficient in the laboratory were also most efficient under commercial conditions. Especial attention has been paid to the development of a satisfactory ration without buttermilk, which is not everywhere available. This has required a study of the fowls' dietary requirements of inorganic salts.

Toward the close of the year the food research laboratory in Philadelphia was discontinued and the work transferred to the branch laboratory in Indianapolis.

#### DAIRY PRODUCTS.

The work to develop analytical and microscopical methods for distinguishing from fresh milk remade milk produced by combining mechanically skim-milk powder, water, and butter fat is, it is believed, approaching a successful conclusion.

The investigation first reported last year to develop methods to appraise the quality of the cream from which a given sample of butter is made has been continued, and it is believed that very valuable practical methods have been developed. Some of these are in process of preparation for publication. Another season's work, it is hoped, will conclude this project, which has an important bearing on certain phases of the enforcement of the food and drugs act.

A paper upon a volumetric method for the detection and estimation of neutralizers in butter and in certain allied products is in press.

An extensive survey of the condenseries and milk-powder plants in the Middle West has been made with a view to determining the character of the milk used. An investigation is in progress to develop methods for estimating the quality of the milk used in the preparation of evaporated, condensed, and dried milk, with particular reference to the bacterial content and the acidity of the raw material. In this connection the use of neutralizers and their detection in the finished product is being studied.

## BEVERAGES.

Papers have been published upon the longevity of bacteria in commercial bottled waters, upon acids in beverages, and upon the clarification and preservation of fruit juices. Much instruction has been given manufacturers upon the best methods of operation, especially in the use of such sugar substitutes as maltose sirup.

## FLOUR AND CEREALS.

Department Bulletin 839, The Microscopical Examination of Flour, proposes a method for the determination of the grade of a flour based on the use of the microscope to count the number of offal particles which differs considerably in the different grades of flour.

Reports have been issued or completed upon a simple method for measuring the acidity of cereal products and its application to sulphured and unsulphured oats, upon the composition and baking value of flour particles of different sizes, upon pearly barley and its manufacture and composition, and upon the laboratory control of wheat-flour milling.

## FOOD FLORA, SPOILAGE, AND FERMENTATION

Reference to the year's work upon the spoilage and the flora of specific articles of food are made elsewhere in this report, where such foodstuffs are specifically considered. The work upon spoilage centered principally upon the study of botulism and upon the study of the spoilage of salmon.

A summary of the bureau's investigations of poisoning due to ripe olives was published in the May 1 number of the Journal of the American Medical Association. Other papers upon the results of the investigations of botulism have been prepared under the titles Botulism from Canned Asparagus and The Possible Pathogenicity of *Bacillus botulinus*. The work on botulism is tending to the study of a number of related bacterial groups as possible causes of a variety of food poisonings related to but not so fatal as botulism. Moreover, it has been shown that massive doses of *Bacillus botulinus* free from toxin when injected subcutaneously or intravenously are capable of producing untoward effects. It seems that similar results may be obtained with other related groups of putrefactive organisms. It is possible that studies of this kind will in time clear up many obscure clinical conditions that are designated in general as ptomaine poisoning but that we know to-day have nothing to do with the presence in the food of the group of chemical substances known as ptomaines.

In the study upon the spoilage of salmon the following reports have been issued: An Aerobic Spore-Forming Bacillus in Canned Salmon; and Bacteriological Experiments with Salmon. Papers have been prepared under the following titles: Bacterial Decomposition of Salmon; and Bacterial Groups in Decomposing Salmon. These studies have given the first information on the bacterial flora of fresh salmon, and they show that the conditions under which salmon are handled in Puget Sound make it possible to keep these fish for at least 48 hours before there is any noticeable invasion of the flesh by

the bacteria that occur upon the skin. It was also found that washing the fish so as to remove the dirt and slime from their skin will delay the invasion of the flesh by microorganisms.

Department Bulletin 819, A Pink Yeast Causing Spoilage in Oysters, was issued.

The work upon oriental fermentations, especially the production of soy sauce from soy beans, is being continued, and a paper has been issued under the title Laboratory Experiments on the Manufacture of Chinese Ang-Khak in the United States. A report on the identity of *Aspergillus oryzae* is in press.

The studies upon the fermentation of pickles and of sauerkraut have been continued, and papers issued upon the pickle investigations of the bureau and upon the control of sauerkraut production by adjusting the temperature, with reports of experiments.

The process for producing vinegar from orange juice has been perfected, and two papers, one upon the production of orange vinegar by the rapid process, the other upon the general subject of the manufacture of orange vinegar and upon its composition, are in press. There is every indication that the production of orange vinegar is establishing itself commercially as a small but valuable industry in the orange-producing sections of California. Orange vinegar can never, because of its cost, compete with cider or distilled vinegar, but it can appeal to a discriminating trade because of its own merits and characteristics.

#### PLANT CHEMISTRY.

A method for the determination of soil acidity has been published under the title, Determining Soil Acidity and Alkalinity by Indicators in the Field, and a paper on soil reaction and plant distribution is in press. In cooperation with the Bureau of Plant Industry, field surveys have been made by this method which indicate that soil reaction greatly influences the distribution of plants. These observations promise to be of great importance in ecology and in agriculture.

There is in press a report which describes definitely the nature of the odorous constituents of apples. Now that these substances are known, it is possible to reproduce the flavor of apples by synthetic means. In the course of this work, it was established that in respiration apples give off acetaldehyde, a discovery of great significance in plant physiology and probably also of practical importance in connection with the storage of apples.

Two papers were published on the constitution of capsaicin, the pungent principle of capsicum, and one upon vanillyl-acyl amides, the series of compounds of which capsaicin is a member. These amides show a definite pungency varying with the size of the molecule. The chemical constitution of capsaicin may now be considered as settled definitely. The reconstituted substance is identical crystallographically with capsaicin.

A crystallographic study of the raphides and crystals of calcium oxalate and other salts in plant cells was begun, with the thought that criteria might be obtained for the identification of plant tissues in food and drug products. It will be necessary to revise the crystallographic and optical data on calcium oxalate, since this substance has not been studied except superficially for 50 years or more. An-



alysis of crystallographically characterized material will be necessary, since the last analysis on record was made in the days when water was HO.

Department Bulletin 803, A Chemical Study of the Ripening and Pickling of California olives, was issued, as well as papers on *Ilex vomitoria* as a native source of caffeine, upon the effect of lime upon the sodium chlorid tolerance of wheat seedlings, and upon pine-needle oils.

Directions have been distributed for the manufacture of citrus-fruit butter and of confections from orange and grape-fruit peel.

### DRUGS AND PHARMACOLOGY.

An exposition of the activities and aims of the bureau's pharmacognosy laboratory was published in the Journal of the American Pharmaceutical Association. The following publications have been issued or prepared: *Santolina chamaecyparissus* L., an Adulterant of *Matricaria chamomilla* L.; The Resin of Man-Root (*Ipomoea pandurata* L.) Meyer, with a Note on Two Other Convolvulaceous Resins; The Crystallography of Morphine and Certain of its Derivatives; Relative Content of Volatile Oil and Ash in Sage Leaves; Partial Analyses of 330 American Crude Drugs; Acid-Insoluble Ash Standards for Crude Drugs; and Commercial Hydrastis (Golden-seal).

A report was issued upon the composition of oil of chenopodium from various sources. The object was to learn whether some of the untoward effects occasionally observed clinically when this oil is used as an anthelmintic could be explained. It was found that certain precautions in the distillation of the chenopodium oil from the plant must be observed in order to avoid the decomposition of the active principle, ascaridole, by prolonged contact with steam or boiling water. Oil distilled in Java was found to be very similar to the oils of American origin. Oil distilled from wild plants collected in Florida was found to contain less ascaridole than the oil distilled from cultivated plants in Maryland. The same constituents were found in it that were found in the Maryland oil. The terpenes of chenopodium oil were found to contain *p*-cymene, *l*-limonene, and probably  $\gamma$ -terpinene. In order to learn whether the therapeutic action of chenopodium oil is dependent solely upon ascaridole there were prepared pure ascaridole, the terpenes of chenopodium oil, and a derivative of ascaridole. These were furnished to the United States Public Health Service and to the International Health Board to be tested for toxicity and anthelmintic action. A report was also issued upon the essential oil of *Rubieva multifida*, a relative of chenopodium, to determine if it might be used in place of oil of chenopodium. It was found to contain phellandren and anethole but no ascaridole.

The work upon the toxicity of gossypol, the phenol found in cotton seed, has been practically completed. It was determined that long-continued feeding of this substance produces perfectly characteristic symptoms, the principal ones of which are loss of weight and appetite and a paresis of the extremities. Careful analyses were also made of different varieties of seeds, and it was shown that they differ

very considerably in gossypol content. In consequence, experiments upon rats were carried out in which different varieties, notably Egyptian, Lone Star, Price, and Durango cottonseed meal, were fed. It was found that the toxicity of different varieties of seed runs roughly parallel with their gossypol contents. It was also found that heating and extraction with certain organic solvents, such as ether, removes the gossypol. It follows, therefore, that in these observations is to be found the explanation of the discordant results that various investigators have obtained in feeding cottonseed meal, either to farm stock or to laboratory animals. It also follows that it should be feasible to so treat cottonseed meal commercially as to remove or destroy practically all the gossypol content of the meal. Recently plants have been constructed for the extraction of cottonseed cake with organic solvents so as to remove the 4 to 6 per cent of cottonseed oil that remains in the press cake. It is likely that this treatment if carried out thoroughly will either completely or very largely remove the gossypol from the cottonseed cake so treated. If this is found to be the case such cake should be more suitable for feeding than ordinary commercial cake and should be relatively non-toxic. It may be possible to feed it in very large quantities.

The work to determine the effect of feeding small quantities of toxic substances over long periods of time by the methods described last year was continued and extended to include several heavy metals, such as lead and zinc, as well as a number of other substances occurring as adulterants in foods. During the war, in cooperation with the Bureau of Biological Survey, an investigation of the effectiveness of various toxic agents in the extermination of rats was undertaken. Strychnine was not found very satisfactory. Barium carbonate was found on the whole quite satisfactory. It was determined that when it was present in the proportion of 20 per cent of the total quantity of the food submitted to the rats practically 100 per cent of the animals died. A manuscript embodying this part of the work has been prepared for publication. Observations were made upon the relative toxicity of different forms of arsenious oxid. It was found that in the finely powdered or amorphous form it was much more toxic than in the form of well-defined crystals. It was about twice as efficient as barium carbonate. Various observations were made which should be of very great value both in the use of barium carbonate and in the use of arsenic as rat exterminators. The work upon arsenic has practically been completed. Papers have been prepared for publication under the following titles: The Toxicity and Physiological Action of Arsenic and Zinc; Observations upon the Intraperitoneal Injection of Fixed Oil; Toxicity of Strychnine for Some of the genus *Mus*; A Comparison of the Effect of Certain Saponins on the Surface Tension of Water with their Hemolytic Power.

#### INSECTICIDES AND FUNGICIDES.

In Department Bulletin 795, The Adulteration of Insect Powder with Powdered Daisy Flowers (*Chrysanthemum Leucanthemum* L.), are described the methods for the detection of this form of adulteration; in Department Bulletin 824, Insect Powder, are described the methods for the detection of the addition of powdered insect flower

stems as an adulterant to insect powder; and in a paper published under the title of *The Microscopical Identification of Mowrah Meal (Bassia)* in *Insecticides* are described the methods for the detection of this adulterant. Studies upon proper standards for hellebore and upon methods for detecting its adulteration are approaching completion.

In Department Bulletin 893, *Experiments on the Toxic Action of Certain Gases on Insects, Seeds, and Fungi*, which was published in cooperation with the Bureau of Entomology, are described the experiments upon the action of phosgene, arsine, cyanogen chlorid, chloropicrin, illuminating gas, and carbon monoxid. Only cyanogen chlorid and chloropicrin give promise of being useful for fumigation purposes. Neither of these war gases, however, can be used in greenhouse fumigation because of their injurious action on plants. Nevertheless, they probably will prove to be of value in the fumigation of stored products.

In Department Bulletin 866, *Pickering Sprays*, are published the results of three seasons' experiments with types of sprays containing smaller amounts of copper sulphate than standard Bordeaux mixture. It was found that such sprays, containing from 0.6 to 0.7 per cent of copper sulphate, controlled fungous diseases on potatoes and cranberries very effectively. Their control of fungous diseases on grapes and apples was not definitely determined, the results being complicated by burning or other injury to the foliage and fruit. It was also found that sprays made with barium hydrate instead of with lime were very successful as fungicides for potatoes. Increased yields of tubers were obtained on plots of potatoes treated with Bordeaux and with a stronger Pickering spray, indicating that these sprays exert similar stimulating and protective action on potato plants. Moreover, the sprayed potatoes yielded tubers with a higher amount of solids than those from unsprayed plots.

One of the investigations upon spraying that has been in progress for some years has been completed, and the results are being prepared for publication. This investigation was planned to determine how much of poisonous elements remain on fruits and vegetables sprayed with poisonous sprays, and also to determine how such poisonous residues may be removed from the fruit or vegetable to be marketed, and finally to determine the conditions of spraying that would yield fruit and vegetables with the smallest possible quantity of objectionable material remaining upon them as they reach the hands of the consumer.

The effect of the various compounds of arsenic on insects, including bees, has been studied, and the manner of action of the various compounds noted. It has been found that even insoluble arsenic compounds seem to be soluble in the bodies of insects. This solubility varies for different compounds and it seems possible to use certain insects as indicators of the insecticidal value of arsenical compounds. There are indications that the compound that shows the highest percentage of soluble arsenic in the bodies of these insects is the best insecticide with respect to killing property. The data are being collected and analyses of bees will be made shortly. It is intended to collect and tabulate all the cooperative data on the subject as soon as the analyses are completed. It has also been found that a com-



pound of copper and barium with arsenious acid, one of a number of new arsenicals prepared in the course of the bureau's work on the improvement of the methods of manufacturing insecticides and fungicides and on the discovery of new insecticides and fungicides, is most effective in killing insects.

Investigations have also been made upon the sticking qualities of lead and calcium arsenate upon various types of foliage, particularly that of the potato.

In cooperation with the Bureau of Entomology, as a part of the boll-weevil campaign, studies have been made to determine how much soluble arsenic cotton plants will stand. For the same purpose, some hundreds of analyses of samples of calcium arsenate, destined for use in combating the boll weevil, have been made for the Bureau of Entomology, in order that no shipments of calcium arsenate unsuitable for use upon cotton might go into the South. It was deemed extremely important that the quality of the insecticide be carefully guarded in order that no prejudice or failure might arise due to the poor quality of some of the insecticides used.

For the Bureau of Entomology studies have also been made of the quantities of hydrocyanic acid that remain in fumigated materials, and for the Bureau of Plant Industry numerous determinations have been made in connection with that bureau's studies upon the control of cereal diseases. For the Insecticide and Fungicide Board more than 600 samples of insecticides and fungicides, including antiseptics, have been examined, and, where necessary, bacteriological tests have been made.

#### DEHYDRATION OF FRUITS AND VEGETABLES.

During the season of 1918 many manufacturers of dehydrated products suffered serious losses through insect infestation. The insect in practically all cases was found to be the Indian meal moth, *Plodia interpunctella*. In cooperation with the Bureau of Entomology, an appropriate investigation was undertaken which made it possible to advise manufacturers how to avoid these losses. The results have been very encouraging, so that during the past season the losses of certain of the manufacturers have been very greatly lessened.

Investigation has shown quite conclusively that vegetables commercially dehydrated without blanching or other pre-treatment deteriorate upon storage. As a result of the bureau's propaganda during the past season, the major portion of the vegetables dehydrated have been processed and will therefore hold up much better when placed on the market. Many plant managers are not as yet adept in the practice of blanching, and much investigation is needed to determine the proper methods for blanching each product. Manufacturers have been placed on the proper road for the production of products of quality.

Much work has been done upon the dehydration of fruits with a view to reducing or eliminating preliminary sulphuring. At the present time some apples are being produced without any sulphuring whatever, while a large volume of fruit is being dehydrated with but very little sulphuring. Some of these products are being mar-

keted at a premium over corresponding sun-dried materials, and it is believed that in time dehydration will largely replace sun drying, because the dehydrated product is superior and the process under many conditions may be more economical.

Work was done in cooperation with the Bureau of Markets on the curing of sweet potatoes and assistance has been given in furthering the proper handling of southern sweet potatoes. A report upon the preparation of sweet-potato flour by the methods that are being used with success in the preparation of white-potato flour has been prepared for publication.

Much propaganda has been made to extend the use of dehydrated products, and large quantities of these materials have been distributed to hospitals, asylums, and other interested parties for the purpose of familiarizing the public with these products and of assisting in the creation of a wider market for them. At present the industry needs much information concerning improved methods of preparing the raw material before dehydration, and more knowledge concerning the chemical changes which occur on deterioration is essential. Future work will be concentrated very largely upon these and related problems.

#### COLOR INVESTIGATIONS.

A general discussion of the work of the color laboratory has been printed in the *Journal of Chemical and Metallurgical Engineering*. The work of this laboratory has been hampered by numerous resignations. Though the staff consists of but 12 chemists, during the few years of its existence it has lost more than 35 men, who have left to fill positions in commercial dye plants. The training of these men in itself represents no small contribution to the progress of the industry. Toward the end of the year the laboratory was moved to the color laboratory building at the Arlington Farm, although the building is not yet completely equipped.

One of the features of the laboratory's work has been the application of optical crystallographic methods in dyestuff research. These methods have been found of the greatest use in the work to determine the purity and character of compounds as well as in other ways. These methods have been introduced to the industry and the bureau's facilities have been placed at the disposal of the industry for the training of experts.

The work upon photosensitizing dyes has been continued. Kryptocyanin (KIII), a new dye with a sensitization maximum at 7,400  $\lambda$ , has been prepared in amounts aggregating several grams. Three dyes of this series have been prepared crystalline. Two of these have been tested at the Bureau of Standards and found to be useful, but not equal in sensitizing action to KIII.

It is reported that more than 100,000 pounds of phthalic anhydride are being produced monthly by the bureau's process and that it is being exported to Europe. The price has fallen so materially that the annual saving probably runs into the hundreds of thousands of dollars. A list which enumerates some 300 different uses for phthalic anhydride and gives the references to the literature and the names of the compounds will be issued shortly.



An idea of the scope of the color work of the bureau can, perhaps, be gained best by examining the list of its researches published or prepared for publication during the year. A few of these papers are mentioned elsewhere in this report. The others are: The Melting Point of Pure Phthalic Anhydride. The System: Phthalic Anhydride—Phthalic Acid; The System: Naphthalene—Phthalic Anhydride; The Vapor Pressure of Phthalic Anhydride; The Fusion of Sodium *p*-Cymene sulfonate with Sodium Hydroxide for the Production of Carvacrol; The Fusion of Sodium Benzene *m*-Disulphonate with Sodium Hydroxide for the Production of Resorcinol; A Synthesis of Thymol from *p*-Cymene; The Preparation of 2-Chloro-5, 6-Dinitrocymene; Purification of Benzoic Acid by Fractional Condensation; The Crystallography and Optical Properties of the Photographic Sensitizing Dye, Pinaverdol; The Absorption Spectra of the Nitric Esters of Glycerol; Some Aspects of the Behavior of Charcoal with Respect to Chlorine; The Production of Hydrochloric Acid from Chlorine and Water; The use of Catalysts in Sulfonation of Aromatic Compounds; Synthesis of *s*-Xylidine.

### LEATHER AND TANNING.

Publications entitled Notes on the Determination of Water Solubles in Leather, and Kaolin for Tannin Analysis have been issued. Reports have been made before technical societies upon waterproofing leather, upon a method for testing materials for increasing the water resistance of sole leather, and upon the relative absorption of oils and greases by wet and dry leather. Articles on the effect of humidity on the strength and stretch of leather, on the value of palmetto and willow bark as sources of tannin and Farmers' Bulletin 1183, The Care of Leather, have been prepared for publication.

Eighteen hundred pairs of Army shoes have been made up from specially selected leather and material. The shoes have been put in service at Camp Funston, Fort Bliss, and Columbus, N. Mex., and have been constantly under the inspection of a member of the leather and paper laboratory. Most of these service tests are nearing completion. A portion of the leather has been cut up into taps for half-soleing. Taps have been numbered and paired off according to contrasting features. Arrangements have been made to repair shoes of policemen, letter-carriers, and civilians with these taps. The records of the wear of these tapped shoes are being kept under the supervision of the laboratory. In this way it is hoped to obtain data supplementing the results from the Army tests. In cooperation with the American Leather Chemists' Association much work was done on the following subjects: The determination of water solubles in leather, the sampling and preparation of leather for analysis, moisture in leather, Epsom salts in leather, the determination of oils and greases in leather.

Among other results it was learned that relative humidity materially affects the tensile strength of leather so that a study is now being made to determine the necessity of testing under controlled conditions of temperature and humidity. This point is of importance since it has been ignored in all work on the strength of leather published in this country, and so far as known has been considered



only superficially in work done abroad. Further work has been done on the preparation of dubbings for shoe uppers and waterproofing materials for sole leather and some of the dubbings and waterproofing compounds are being tried out in the Army service tests mentioned.

Experiments have been made to develop methods for tanning leather on a small scale that can be used, especially by farmers, for home-tanning operations. Only simple, inexpensive homemade equipment was used and materials that are easily available. A farmers' bulletin on the subject is being prepared, since, judging from the large and increasing number of inquiries, there is a great demand for this sort of information.

Farmers' Bulletin 1055, *Country Hides and Skins: Skinning, Curing, and Marketing*, was published in cooperation with the Bureau of Markets and the Bureau of Animal Industry. It describes the correct method for skinning, curing, and marketing country hides and skins. Also a poster, *More Money for Better Hides*, was widely distributed. Both were in such demand that within a few months after publication a reissue of each was necessary. As a means of strikingly illustrating the importance of this subject, elaborate displays of defective hides and leather were assembled, and through the cooperation of the Office of Exhibits were exhibited at the various State fairs throughout the country and at the international live-stock exhibition in Chicago. The exhibits thus visualized the serious consequences of carelessness in skinning, curing, and marketing, and of excessive branding, and the damage caused by pests such as the grubworm.

Assistance has been rendered to some of the northern tanners by determining, in cooperation with the Bureau of Animal Industry, the character of a peculiar defect of certain skins which is not apparent until the skins are split. The trouble was found to be due to the follicular mange, and suggestions were given the tanners to aid them in detecting such defective skins before splitting, thereby saving many skins suitable for certain kinds of leather, but almost an entire loss for split leather.

An investigation of the difficulties experienced by a near-by tanner in unhairing a certain lot of hides showed that this was due to curing with salt containing alum, which set the hair in the skin and consequently reduced the value of the hide. A news note bringing out this point has been published.

Samples of oak bark improperly prepared for leaching have been analyzed for tannin after commercial extraction and found to have been very poorly extracted. The attention of several tanners was called to this extravagant practice, avoidance of which should result in a marked saving of tanning materials.

Some time has been given to the improvement and more general utilization of domestic sumac, to establishing grades of sumac, and to inducing purchasers to pay a price commensurate with the quality.

#### PLANT DUST EXPLOSIONS AND FIRES.

As no specific appropriation was made for this work, on July 16, 1919, the United States Grain Corporation appropriated \$50,000 for the continuation of the educational and investigational work carried on by the bureau during the preceding years. Nearly the whole force of the bureau that had been engaged upon this work was transferred

to the rolls of the Grain Corporation, only the leaders remaining upon the roster of the Bureau of Chemistry. Active inspection was carried on in mills and elevators in which the Grain Corporation had wheat or stocks of flour in storage to secure the removal of hazardous conditions and the installation of devices which have been developed for the prevention of fires and explosions. Special literature, consisting of circulars, posters, and folders, was prepared and circulated among the owners and employees of the mills and elevators throughout the country.

On September 13 a disastrous explosion occurred in a Kansas City grain elevator, with a loss of 14 lives. The loss to the Grain Corporation was about \$25,000, which represented almost the total losses from such causes during the entire period of its existence. It never had stocks of a value less than \$100,000,000 on hand, and they often amounted to \$500,000,000. With the passing out of existence of the Grain Corporation toward the end of the year, the force was disbanded and the work discontinued.

Owing to lack of funds, little work could be done to prevent thrasher explosions and fires. Except for field demonstration, this project is closed, but such work is urgently needed. For lack of it a large number of explosions and fires occurred in the Walla Walla territory in southwestern Washington, causing extensive damage to grain and machines. Department Circular 98, The Installation of Dust-Collecting Fans on Thrashing Machines, has been issued.

For lack of funds the work upon the study of fires in cotton gins was limited to correspondence and conferences with manufacturers of machinery, fire marshals, underwriters, and other interested parties.

In cooperation with the National Lamp Works, the Westinghouse and the Edison companies, it was demonstrated that dust explosions can be caused by the breaking of any type of incandescent-lamp bulb. Work was done at Cleveland, at the Edison plant at Harrison, at the Westinghouse plant at Bloomfield, and at the Pennsylvania State College. The object of the engineers of the lamp companies is to develop equipment that will remove some of the dangers and make it possible to establish safe practice.

#### PAPER, CONTAINERS, AND FABRICS.

As reported in 1917, the investigations on blue-print paper have been of service in establishing more solidly the manufacture of such paper in this country, and it is now possible for the Government, and engineers generally, to procure in this country all the blue-print paper needed, of a quality superior to that formerly obtained from abroad. During the year, at the request of the Navy Department, the specifications for blue- and brown-print paper were revised, after which they were adopted by the Navy Department. In a similar manner the bureau was called upon by the War Department, Treasury Department, Shipping Board, and the General Supply Committee. An effort has been made toward the adoption throughout the Government service of uniform specifications for the purchase of blue- and brown-print paper, of which at least 500,000 pounds are consumed annually. Specifications for the production of water-resistant papers for baling have been published.



Paper products, fiber board, wall board, and water-resistant wrapping papers are rapidly replacing wood and even tin as containers for certain kinds of food and merchandise. There are no methods for testing these materials or insuring the manufacture of a satisfactory box board that will withstand the forces of destruction met with in transportation, especially in overseas shipments. Neither is there any satisfactory method for determining the strength of fiber board, wall board, corrugated board, or water-resistant baling papers. Much work has been in progress in the last three years on these subjects, and some of the results have been published in the form of a description of an impact tester for fiber board, as well as a report upon water-resistant papers for baling.

The investigations relating to the water resistance of fiber board and the adhesives used in the manufacture of solid and corrugated fiber board and wall board have greatly stimulated the interest of the industry, especially those on the effect of silicate of soda when used as an adhesive on fiber board and on the value of the proper sizing of the board in increasing its water resistance. Following the work of the bureau on fiber board, the silicate of soda manufacturers and the fiber board associations established two fellowships at the Mellon Institute to investigate their technical problems. A much more intelligent and conservative use of silicate of soda has resulted from the bureau's work. Economy in silicate has been effected and a more durable water-resistant board is being made, although the deteriorating effect of silicate of soda on fiber board has not been overcome entirely.

Factory scale experiments have been made on the use of the adhesives from corn cobs, the production of which was described in 1919. Commercial mill runs have shown that this adhesive has great value in the production of corrugated and other fiber board. Valuable results have been obtained and board manufacturers very favorably impressed. Laboratory tests have given indications that both the corn-cob adhesives and certain kinds of purified concentrated sulphite cellulose liquors are very useful adhesives.

The results of the investigations upon the examination of enamel ware and upon the use of hydrogenated oils in place of palm oil in the manufacture of tin plate, described last year, have been published this year. Investigations of the suitability of different types of containers for the storage of baking powders and of dehydrated vegetables and fruits have been completed and prepared for publication.

Specifications for the purchase of waterproofing and mildewproofing for canvas and of waterproof automobile top dressings have been prepared at the request of the War Department, and samples of waterproofing materials have been tested and advice given on the award of contracts. By this means the bureau was instrumental in saving the War Department approximately \$24,000 on a single requisition and in securing a material much superior to that which it was on the point of ordering at about three times the price. Some of the indications from this work are (1) that the oleates of the heavy metals are more toxic than stearates to fungi; (2) that the soaps appear to fall in the following order in their inhibitive effect, barium, magnesium, calcium, strontium, mercury, manganese, lead, iron, cobalt, copper, zinc, nickel, aluminum, and chromium; (3) that



*Aspergillus niger* and *Penicillium* show a high degree of resistance to metallic soaps. A paper covering the work on soaps of the heavy metals is in preparation. Papers on methods of testing the water resistance of fabrics and on testing the mildew resistance of fabrics have been published. Farmers' Bulletin 1157, Waterproofing and Mildewproofing of Cotton Duck, is in course of publication.

#### NAVAL STORES.

Department Bulletin 898, Turpentine: Its Sources, Properties, Uses, Transportation, and Marketing, with Recommended Specifications, is in press. It endeavors to present to the producer and consumer certain elementary but very important information of great use to the industry.

#### METHODS AND APPARATUS.

Methods have been published for the estimation of monobromated camphor in migraine tablets, of water solubles in leather, of iodid and bromid in mineral waters and brines, of saccharin in urine, and of caffeine in vegetable material.

Papers have been published on the use of kaolin in tannin analyses and on the combination of fractionation with spectrophotometry in proximate organic analysis. Papers are in press on a color test for oxalic acid and on the Kjeldahl nitrogen method and its modifications. Reports are in press upon methods for the estimation of phosphatides, for the detection of neutralizers in butter, for the estimation of phenolphthalein, and for the separation of magnesium from sodium and potassium chlorids.

As a by-product of the regular testing to which all chemical reagents purchased by the bureau are subjected, notes upon sulphuric acid free from nitrates and the diphenylamine test for nitrates, upon potassium ferricyanide, upon methyl orange, and upon the quality of the chemicals received by the Bureau of Chemistry during the war were published.

There were distributed to the chemists of the bureau and to collaborating chemists information sheets containing critical discussions of the methods of examining the following products: Condensed milk, sweetened condensed milk, milk, cream, and oysters.

#### ANALYTICAL WORK FOR OTHER DEPARTMENTS AND BUREAUS.

Because of the return of the various Government establishments to a normal basis, only about one-third as much analytical work was done for them this year as last. The figures are collected in Table 5. In addition, a number of extensive investigations were carried out for other Government establishments, and much advisory work on the preparation of specifications and the like was done. The usual assistance was given the Post Office Department in connection with fraud-order cases.

For other bureaus of the Department of Agriculture a great deal of analytical work was done. For example, nearly 1,000 samples of insecticides and fungicides were examined for the Insecticide and

Fungicide Board, the Bureau of Entomology, and the Bureau of Plant Industry. More than 200 samples of water were examined for the Bureau of Public Roads, in connection with an investigation of the causes of deterioration of cement tile. The failure of cement tile to withstand the action of the soil and drainage waters is especially marked in southwestern Minnesota.

TABLE 5.—*Samples analyzed for other departments.*

Departments.	Number of samples.	Departments.	Number of samples.
Department of State.....	4	The Panama Canal.....	33
Department of the Treasury.....	843	District of Columbia.....	9
Department of War.....	2, 723	General Supply Committee.....	34
Department of Justice.....	501	Federal Trade Commission.....	3
Post Office Department.....	148	United States Grain Corporation.....	152
Department of the Navy.....	544	Miscellaneous.....	29
Department of the Interior.....	53		
Department of Commerce.....	322	Total.....	5, 398

## REPORT OF THE CHIEF OF THE BUREAU OF SOILS.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS.

*Washington, D. C., August 19, 1920.*

SIR: I have the honor to transmit herewith a report covering the operations of the Bureau of Soils for the fiscal year ended June 30, 1920.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

HON. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### INTRODUCTION.

Sufficient time has now elapsed since the armistice to enable us to consider carefully and take stock of the achievements of the bureau during the feverish activities of the period of actual war and during the months of readjustment that followed. This survey brings out the fact that both in soil work and in fertilizer investigations many important advances have been made, with results that it is imperative to save and to introduce into commercial activities. To fail in this would be to lose a great opportunity to develop and perfect new commercial enterprises for the reconstruction period before us.

### SOIL SURVEY.

During the fiscal year ended June 30, 1920, detailed soil surveys were completed or begun in 67 different areas, located in 31 different States. The area surveyed in these projects was 29,784 square miles or 19,061,760 acres. Reconnaissance surveys conducted in Texas covered 11,825 square miles, or 7,568,000 acres.

The total area covered by detailed surveys from the inception of the work to and including June 30, 1920, amounts to 547,733 square miles, or 350,549,120 acres, and by reconnaissance surveys 516,286 square miles, or 330,423,040 acres. This is a total of 1,064,019 square miles, or one-third of continental United States. There are in the Western States of course large areas of mountain lands and of deserts, where there is no immediate prospect of irrigation or of grazing, for which there will likely be no need of soil surveys.

The following tables show the areas surveyed during the fiscal year just closed and the total area surveyed in each State up to the present time:



TABLE I.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1920.*

## DETAILED.

State.	Area.	Area surveyed.	
		Square miles.	Acres.
Alabama.....	Choctaw County.....	191	122,240
	Crenshaw County.....	618	395,520
	Geneva County.....	1 321	205,440
	Houston County.....	1 134	85,760
	Marengo County.....	1 64	40,960
Arkansas.....	Lonoke County.....	1 340	217,600
	Perry County.....	1 256	163,840
California.....	Brawley area.....	1 356	227,840
	Shasta Valley.....	1 280	179,200
Delaware.....	Sussex County.....	1 497	318,080
Florida.....	Duval County.....	1 287	183,680
Georgia.....	Mitchell County.....	1 177	113,280
	Monroe County.....	584	373,760
	Screven County.....	794	508,160
Idaho.....	Kootenai County.....	2,043	1,307,520
Indiana.....	Decatur County.....	378	241,920
Iowa.....	Adair County.....	573	366,720
	Cedar County.....	570	364,800
	Fayette County.....	1 560	358,400
	Johnson County.....	610	390,400
	Mahaska County.....	1 440	281,600
	Woodbury County.....	654	418,560
	Wright County.....	1 469	300,160
Kansas.....	Leavenworth County.....	440	281,600
Kentucky.....	Logan County.....	1 290	185,600
	Muhlenberg County.....	1 116	74,240
Louisiana.....	Natchitoches Parish.....	501	320,640
Maryland.....	Carroll County.....	1 57	36,480
	Frederick County.....	663	424,320
Massachusetts.....	Barnstable County.....	409	261,760
	Bristol County.....	1 402	257,280
Mississippi.....	Choctaw County.....	1 182	116,480
	Smith County.....	1 261	167,040
Missouri.....	Polk County.....	1 492	314,880
	St. Louis County.....	1 371	237,440
Nebraska.....	Banner County.....	1 502	321,280
	Dakota County.....	256	163,840
	Howard County.....	168	107,520
	Lancaster County.....	225	144,000
	Redwillow County.....	1 565	361,600
	Sioux County.....	1 1,935	1,238,400
New Jersey.....	Bernardsville area.....	1 206	131,840
	Chatsworth area.....	1 497	318,080
New York.....	Wayne County.....	1 476	304,640
North Carolina.....	Durham County.....	291	186,240
	Guilford County.....	442	282,880
	Onslow County.....	306	195,840
	Tyrrell County.....	390	249,600
North Dakota.....	McHenry County.....	689	440,960
Ohio.....	Fulton County.....	119	76,160
Oregon.....	Benton County.....	269	172,160
	Josephine County.....	1 1,542	986,880
	Multnomah County.....	1 291	186,240
Pennsylvania.....	Lycoming County.....	1 736	471,040
South Carolina.....	Greenville County.....	1 295	188,800
	Spartanburg County.....	1 230	147,200
South Dakota.....	Beadle County.....	647	414,080
Tennessee.....	Henry County.....	220	140,800
	Bedford County.....	258	165,120
Texas.....	Dallas County.....	1 251	160,640
	Erath County.....	1 619	396,160
	Red River County.....	219	140,160
	Tarrant County.....	1 297	190,080
Utah.....	Delta area.....	155	99,200
West Virginia.....	Fayette County.....	667	426,880
Wisconsin.....	Racine County.....	324	207,360
	Walworth County.....	1 317	202,880
Total.....		29,784	19,061,760

## RECONNOISSANCE.

Texas.....	Northwestern Reconnaissance.....	1 11,825	7,568,000
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<sup>1</sup> These figures do not include portions of these areas surveyed in preceding years.

TABLE II.—Areas surveyed and mapped in the several States during the fiscal year ended June 30, 1920, and the areas previously reported.

## DETAILED.

State or Territory.	Work during 1920 (square miles).	Work previously reported (square miles).	Total.	
			Square miles.	Acres.
Alabama.....	1,328	46,603	47,931	30,675,840
Arizona.....	.....	961	961	615,040
Arkansas.....	596	11,934	12,530	8,019,200
California.....	636	19,878	20,514	13,128,960
Colorado.....	.....	2,809	2,809	1,797,760
Connecticut.....	.....	1,704	1,704	1,090,560
Delaware.....	497	1,779	2,276	1,456,640
Florida.....	287	11,811	12,098	7,742,720
Georgia.....	1,555	25,062	26,617	17,034,880
Idaho.....	2,043	6,288	8,331	5,331,840
Illinois.....	.....	6,770	6,770	4,332,800
Indiana.....	378	11,062	11,440	7,321,600
Iowa.....	3,876	16,942	20,818	13,323,520
Kansas.....	440	9,016	9,456	6,051,840
Kentucky.....	406	4,189	4,595	2,940,800
Louisiana.....	501	13,653	14,154	9,058,560
Maine.....	.....	2,197	2,197	1,406,080
Maryland.....	720	6,788	7,508	4,805,120
Massachusetts.....	811	1,659	2,470	1,580,800
Michigan.....	.....	5,708	5,708	3,653,120
Minnesota.....	.....	5,301	5,301	3,392,640
Mississippi.....	443	24,462	24,905	15,939,200
Missouri.....	863	31,405	32,268	20,651,520
Montana.....	.....	882	882	564,480
Nebraska.....	.....	22,234	25,885	16,566,400
Nevada.....	3,651	235	235	150,400
New Hampshire.....	.....	1,411	1,411	903,040
New Jersey.....	703	6,399	7,102	4,545,280
New Mexico.....	.....	596	596	381,440
New York.....	476	19,422	19,898	12,734,720
North Carolina.....	1,429	29,435	30,864	19,752,960
North Dakota.....	689	13,227	13,916	8,906,240
Ohio.....	119	10,102	10,221	6,541,440
Oklahoma.....	.....	6,540	6,540	4,185,600
Oregon.....	2,102	3,780	5,882	3,764,480
Pennsylvania.....	736	15,165	15,901	10,176,640
Porto Rico.....	.....	330	330	211,200
Rhode Island.....	.....	1,085	1,085	694,400
South Carolina.....	525	21,880	22,405	14,339,200
South Dakota.....	647	675	1,322	846,080
Tennessee.....	478	8,925	9,403	6,017,920
Texas.....	1,386	30,957	32,343	20,699,520
Utah.....	155	1,951	2,106	1,347,840
Vermont.....	.....	1,175	1,175	752,000
Virginia.....	.....	9,713	9,713	6,216,320
Washington.....	.....	10,752	10,752	6,881,280
West Virginia.....	667	16,015	16,682	10,676,480
Wisconsin.....	641	16,227	16,868	10,795,520
Wyoming.....	.....	855	855	547,200
Total.....	29,784	517,949	547,733	350,549,120

## RECONNOISSANCE.

Alaska.....	.....	31,915	31,915	20,425,600
Arkansas-Missouri.....	.....	58,000	58,000	37,120,000
California.....	.....	32,135	32,135	20,566,400
Kansas.....	.....	39,960	39,960	25,574,400
Nebraska.....	.....	53,064	53,064	33,960,960
North Dakota.....	.....	39,240	39,240	25,113,600
Ohio.....	.....	41,420	41,420	26,508,800
Pennsylvania.....	.....	41,405	41,405	26,499,200
South Dakota.....	.....	41,400	41,400	26,496,000
Texas.....	11,825	98,382	110,207	70,532,480
Washington.....	.....	13,115	13,115	8,393,600
Wisconsin.....	.....	14,425	14,425	9,232,000
Total.....	11,825	504,461	516,286	330,423,040

The Soil Survey is contributing its share to the development of American agriculture by placing in the hands of the people detailed knowledge of the soils of the country. This work is fundamental in character, its value in this respect is clearly recognized, and the demands for it are increasing far beyond the ability of the bureau to meet them with its present limited resources. These demands come from many different interests. Prominent among them are the requests from development companies interested in opening large tracts of cut-over land to settlement. Exact information about the soils and the general character of crops that can be grown is wanted at once to assist the new settlers in making the right start. Such knowledge frequently saves years of experimental work. There is also an increasing demand for soil surveys from investigators working in almost every field of scientific agriculture. The requests for surveys from county farm advisers and extension-service directors have been especially numerous and insistent. The peculiarities, or the individuality, of our various soils must be taken into account if we are to make progress in plant breeding and selection, in fertilizer practice, in cultivation—in fact, in all work looking to the improvement of cultivated crops. The soil-survey work is thus the basis for planning and experimentation of the various activities of the agricultural experiment stations, and farms and experimental plots for varietal and fertilizer tests are being established on the large and important soil types of the United States.

The introduction of agricultural instruction in common schools as well as high schools and the extension of agricultural schools has created a demand for knowledge of the soils and of general agricultural conditions of the country contained in the soil-survey reports. In many of the colleges regular courses in soil surveying have been established.

Most of the work of the Soil Survey is carried on in cooperation with State organizations, such as agricultural colleges, experiment stations, departments of agriculture, and geological surveys. During the fiscal year the following States contributed funds to help carry on the work: Alabama, California, Delaware, Georgia, Idaho, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wisconsin. It is a significant fact that during the rush of war work the States continued their cooperation in the soil survey with nearly undiminished vigor, recognizing this to be a fundamental basis for their experiments and development activities to meet the war conditions as well as to prepare for peace conditions. The bureau has been unable with its limited appropriation to meet fully the demands of the States for cooperative work and to meet cooperation in new States and has had to curtail operations in States that have heretofore been cooperating.

Besides the State cooperation, the bureau cooperated with the War Department with a view to determining the value of land taken for camp sites, with the Office of Indian Affairs, and with the Reclamation Service of the Department of the Interior. About the usual amount of work was done in cooperation with the several bureaus of the department.



Much advice and information by correspondence was given during the year by the section of soil information. Many persons contemplating the purchase of land or who have recently acquired land seek information regarding the character of the soils in their prospective or actual holdings, and the kinds of crops which may be most profitably produced thereon. The requests for advice by persons desiring to plant gardens have been very numerous. This section has also assisted in the preparation of exhibits to be shown at a number of the more important agricultural fairs.

Of the institutions of the world concerned with the fundamental and scientific study of the basic agricultural resource of any large area, the Soil Survey of this department is by far the most important. **No other nation has undertaken at any time so detailed and at the same time so comprehensive a study of its soils as is now being carried on by the Soil Survey.** Its work is scientific in method and geographic in its type, but its results are applicable at once to the practical work of agriculture. It has contributed greatly and is contributing to the development of the new science of the soil, a science that stands in intimate association with geology, climatology, and the geographic side of biology. It is one among the sciences whose progress has been greatly promoted by the great geographic extent and wide range of geographic conditions to be found within the bounds of the United States.

Science has never yet undertaken a detailed formulation of a statement showing the relative importance in agricultural production of the various characteristics of the soil. There has been a great deal of discussion regarding fertility, but no careful attempt has been made to determine in detail what are the various factors of fertility or productivity and what is their order of importance. It has not been possible to do this because of the lack, until recently, of any great body of accumulated facts regarding the soils as they occur in their natural habitat, their characteristics, and their relation to agricultural production. The Soil Survey is the institution engaged in this study and in the accumulation of this great body of facts, and such progress has already been made that at least a preliminary statement may now be formulated from the accumulated results. This is merely one of the many fundamental principles of great practical value for which scientifically gathered facts have been obtained by the Soil Survey.

Aside from its practical value the Soil Survey as an institution of research is meeting the obligations which every such institution has to advance the sum of human knowledge of facts and principles. The fortunate geographic position, great extent, and widely varied conditions existing within the United States have permitted the Soil Survey to study the development of soils under a wider range of conditions than is possible within the area of any other country of the world. This presents to us an opportunity and places on us an obligation. We owe it to ourselves to take advantage of the opportunity and to the scientific world to cultivate to the greatest extent within our powers the vineyard placed under our care.

Many attempts have been made at land classification. Practically none of them have been based on the soil, or have even taken the soil into serious consideration, because of the lack until within very recent years of any systematically accumulated body of data on the soil for

an area large enough to make classification on the soil basis possible. Classifiers have fallen back on geology, climate, topography, or native vegetation, all of which have their value, but such bases make a classification indirect and approximate only. The Soil Survey has now covered the eastern, central, and a large part of the far western part of the country in sufficient detail to make the use of soil data in land classification possible.

During the calendar year of 1919 extensive studies were made of most of that part of the Great Plains about which our knowledge of soil conditions is most deficient, for the purpose of accumulating data to be used in the classification of the lands in this part of our domain. The work is done in cooperation with the Office of Farm Management, as the office in general charge of the project, with various other bureaus of the Department of Agriculture, and with the Geological Survey of the Department of the Interior.

The study of the chemical composition of the virgin soils of the United States in cooperation with the Division of Chemical Investigations has progressed satisfactorily, considering the employment difficulties encountered by all the chemical laboratories of the department. About 50 samples have been collected by the Soil Survey during the year and complete analyses have been made of all of them.

#### GENERAL SOIL MAP OF THE UNITED STATES.

The work on the general soil map of the United States for the Atlas of American Agriculture is progressing satisfactorily and will be finished before the close of the calendar year 1921. A draftsman has been assigned to this project alone and has already compiled the results of the Soil Survey work in most of the States east of the 100th meridian.

#### PREPARATION OF STATE SOIL MAPS.

In some of the States the surveying of the soils is nearing completion, and it is time to make some provision for assembling the county maps into more condensed State soil maps so that we may see at a glance the soil resources of a State. This will necessitate the revision of some of the older soil surveys and the bringing of the great mass of data in the county maps into one harmonious map.

#### THE PERMANENCY OF THE SOIL AS AN AGRICULTURAL ASSET.

Since the earliest historic times agricultural writers have speculated as to the length of time the soil can be used to support the increasing population of the world. This speculation still continues, and in our country there are well-informed people who believe that the continued growing of crops depletes the soil to such an extent that they predict the complete exhaustion of some of our most fertile soils within a comparatively few years unless enriched from time to time with foreign material pound for pound for the plant food removed by the crops. The Bureau of Soils does not hold this opinion, but believes that the soil has certain regenerative properties which will permit its use for agriculture for an indefinite time, whether the actual yield of crops shall decrease or increase during a term of occupation of the land depending upon the knowledge and skill of the cultivator. This question can be settled definitely only by a study

of the soils about the great centers of civilization whose populations have lived in large measure on the products of the soil of their immediate vicinities.

Accurate data relating to the soils around London, Paris, Madrid, Rome, Athens, Constantinople, in Roumania and India, and about Pekin and Tokyo, such as are contained in our own detailed soil surveys, including a study of soil formations, correlating them as nearly as possible with our own soil types, information as to the length of time such lands have been under cultivation, with records of yield and laboratory analyses of samples—these to be compared with similar studies in South America and British North America, where the soils have never been used for agricultural purposes—would be a decided contribution to our scientific knowledge of soils and would ultimately be of unquestionable value to practical agriculture.

### CHEMICAL INVESTIGATIONS.

During the year the laboratory of soil chemical investigations has done the usual large amount of routine work. Many complete or partial analyses of soils have been made for the Soil Survey, for other bureaus of the Department of Agriculture, and for other departments of the Government, as well as for hundreds of farmers, gardeners, and city and suburban dwellers. There have also been the usual routine investigations of the effect of lime and other fertilizers on the soil.

There are two lines of investigation, however, that stand out prominently as fundamental advances in the science of soils, and which it is believed if carried out with a larger force will have very important results on the practice of agriculture. Both of these lines have been under investigation for some years, but have only during the last year taken that definiteness that permits of their being announced in this public way.

Chemists have long been dissatisfied with the interpretation of the chemical analyses of soils, as the results have been of only relative value and little was known of the actual constitution of the materials which were found.

The Bureau of Soils has at last been able to treat soils in ton lots and to determine the actual crystalline form of many of the soil constituents. It has been found that the salts occurring in the soil solution are much more complex than had been realized, and that the salts in the soil mixture are of the same general type as those in the Stassfurt deposits of Germany and in the beds of former inland seas and lakes that have evaporated and left their salts as deposits. This might have been foreseen, for the soil is the original source of these deposits that have been carried by the rivers into the sea and finally left by evaporation after the water supply has been cut off. Still it is striking to find in our ordinary soils such well-known minerals as kainit, carnallite, kieserite, and sylvite, which commercially are known only in connection with such deposits as occur at Stassfurt. The soil, therefore, appears to be a miniature Stassfurt deposit.

Sufficient progress has been made to show that these complex mineral salts differ in some respects in our different soil types. What the significance of this is in practical agriculture has not yet



been determined. It is a well-known fact that in a complex solution of this kind the addition of another salt may more or less completely change the system. Temperature and other factors also enter in changing the forms that are left on evaporating such a solution to dryness. It is at least probable that the addition of fertilizer materials to the soil may change the system, and that they may tend to change the relation of the soil to the life activities of the plant.

This investigation should be pushed much further than is possible with the limited funds now provided.

In working up large lots of soil for the extraction of these mineral bodies considerable trouble was encountered owing to the presence of colloidal matter that had to be disposed of. This material has itself been studied, and it has been found possible to separate it by the use of the centrifuge from the insoluble mineral particles, when it appears as a true colloid, very sticky and plastic when wet and having in the dry state the general appearance of a resin. It appears to be a silicate of alumina, usually with some iron and a trace of potassium, sodium, magnesium, and calcium, whether combined or merely absorbed having not yet been determined. We have designated this material "ultra-clay."

When this material is separated completely from the mineral particles of the soil, the soil, even the most plastic soil, appears to lose much of its plastic properties. When this material, up to 10 per cent of the weight of the sand, is added to a loose and incoherent sand, made into briquettes, and dried, it gives to the sand a crushing strength greater than if an equal amount of Portland cement had been added. There is, however, this difference, that the dried briquettes made up with Portland cement do not fall to pieces on adding water, while the briquettes made up with ultra-clay when put in water fall to pieces.

It appears evident from the results so far obtained that this is the material that gives plasticity and binding power to ordinary soils. It is, therefore, of vital importance that a full and comprehensive study be made of the ultra-clay from different soil types and that if possible some way of controlling its adhesive powers be discovered. This has an important bearing upon the physical properties of soils, and is of importance to the engineer in connection with the foundation of buildings and of roads. The bureau is cooperating with the Bureau of Public Roads along these lines.

It has been found that ultra-clay is very absorbent of mineral matters and of certain organic matters, and that in the dry state it will absorb under similar conditions as much ammonia gas as will charcoal.

The division of soil chemistry must prepare quantities of this material from our principal soil types and study its chemical constitution both as a basis for determining the differences in soils and to see if its properties can be modified at will.

#### SOIL PHYSICS.

A part of the personnel of the Division of Physical Investigations of Soils has continued to cooperate with the War Department in the study of the Haber process for nitrogen fixation. Results of these investigations are noted under the report of "Fertilizer resources."

Mechanical analyses of soils for the Soil Survey have been continued, and many analyses also have been made for other bureaus and departments of the Government. The standardization and repair of instruments has provided necessary equipment that would have been difficult to obtain from outside sources without much delay.

This division has been cooperating with the Division of Soil Chemistry in the study of the ultra-clay and its physical effects on soils. This work should be continued and considerably extended, as the whole subject of the tenacity of soils, their baking and plasticity, and the cultural methods for their amelioration or modification, is involved.

#### FERTILIZER RESOURCES INVESTIGATIONS.

The work covering fertilizer resources, originally started under the limited funds at the disposal of the bureau, has developed to a remarkable extent. Many of the lines of investigation have been carried so far as to make it advisable to ask for specific appropriations in order that the methods developed may be carried to a point where they can be safely taken up by commercial organizations.

Some of the more important lines of investigation prosecuted under the general project will be discussed in connection with specific subjects. There are a great many other lines of investigation associated with new forms and sources of materials that can be continued and extended provided separate appropriations are made for the important lines already developed.

During the year the Division of Fertilizer Resources continued along the broad lines of fertilizer work followed in previous years, with a view to determining our resources in fertilizer materials, and to furnishing these to the farmer in the most economical, satisfactory, and available form.

In addition to the collecting of statistical data and the furnishing of technical information regarding fertilizers, their sources, supply, and manufacture, and advising on many problems arising in Government control, we have taken up a number of lines of special research work. In some of these we have worked in cooperation with other Government agencies and especially with the War Department upon the problems of nitrogen fixation.

On account of the increased fertilizer prices, due in part to the use of organic ammoniates for feeding purposes, we have stressed the work of the bureau on concentrated fertilizers, more especially with products which may be produced by the Government or by private plants. The introduction and use of these products should in part, at least, make up for the increasing cost of fertilizers, following upon the increased cost of material, and of freight rates, handling charges, labor, etc.

#### FERTILIZER CONTROL.

During the year the bureau exercised fertilizer control under the President's proclamation, having taken over the duties formerly assigned to the Office of Fertilizer Control. Many fertilizer companies have been put under license; in other ways a close supervision of trade conditions has been maintained, and steps have been taken to develop, as far as possible, new fertilizer sources.

The control exercised has, we believe, aided in protecting the farmer from exploitation by ignorant or unscrupulous manufacturers and dealers, through the sale of relatively valueless or harmful products. Thus, by reason of the authority granted in the proclamation, the department was able to put out a ruling on borax in fertilizers which has been widely commended for its efficient and rapid elimination of this deleterious substance from fertilizer mixtures. This ruling protected the farmer and the manufacturer alike in the use of material which would not ordinarily be suspected of deleterious effect.

With the conclusion of peace, the power now exercised under the President's proclamation will cease. In view of this, it is strongly recommended that Congress pass a national fertilizer-control law continuing a part of the fertilizer control in this department. It is felt that the loss of power to protect the farmer from exploitation and deceit by unscrupulous manufacturers and dealers would be a national calamity. On the other hand, Federal control would work for the best interest of the fertilizer trade, in that the business would be kept on a high plane. A national fertilizer law would do for the commercial fertilizer industry what the national food and drug act has done for the pharmaceutical and food industries, and in the same way would benefit the farmer and the general public.

#### NITROGEN FIXATION.

For the nitrogen-fixation work the bureau has been largely dependent on certain special funds set aside by the War Department for material and labor, but also has drawn heavily upon its several divisions for personnel. The bureau should have ample authority to carry on this work, in view of the fact that the future policy of the War Department has not been determined and depends somewhat upon action of Congress.

The European War has emphasized certain activities and has brought about certain conditions which make it imperative that we establish our independence regarding sources of fertilizer materials. The necessity for nitrogen independence has been recognized by practically all of the leading countries of the world. Germany had established her nitrogen independence before the beginning of the World War. In truth, probably the fact that she alone of all the nations involved had ample nitrogen supply within her borders led to the belief that this would give her such an advantage that it would be the deciding factor in victory. England, France, and Italy are all perfecting plans to make themselves equally secure regarding nitrogen supply, and the greatest activity is being shown by them in investigational work on the subject. This country can not afford to fall behind the rest of the world on a question of so vital importance both in peace and in war. As a result of this recognition of the importance of nitrogen, there have been greatly increased activities in the investigation of methods for fixing nitrogen. The knowledge of fixation processes within the United States has been rather limited, however.

During the war two plants for nitrogen fixation were constructed, one at Sheffield and one at Muscle Shoals, Ala. As an emergency proposition the construction of these plants was fully justified, but



a considerable study of the processes involved will be necessary in order to make them useful during peace time. The products of these plants must be available for use as fertilizers and readily convertible into munitions in time of war. Proper use of them is closely associated with other fertilizer problems and with transportation problems.

Methods for preventing the great loss now suffered in mining phosphate rock have shown that phosphoric acid can be prepared in a form suitable for the absorption of ammonia. Inadequate transportation equipment has emphasized the importance of conserving car space as much as possible. By proper use of our nitrogen fixation plants it may be possible to manufacture concentrated fertilizers containing only the three important fertilizer ingredients—nitrogen, phosphoric acid, and potash. The development of the fertilizer industry is toward the manufacture of such a concentrated fertilizer. In this way an enormous amount of car space will be made available for other purposes and a large saving in freight rates, paid on inert material now going into fertilizers, will be effected. In establishing this method of utilizing the nitrogen plants, of conserving phosphate material, and of reducing freight charges, as has been indicated, there are still many questions that must be investigated.

This bureau initiated work along these lines several years before the World War. Work on the Haber process for nitrogen fixation was begun and carried on by this bureau, and at the entrance of the United States into the war the Ordnance Department requested the use of the experimental apparatus constructed at the Arlington Farm Laboratory. A considerable force from the War Department was assigned to this laboratory until the armistice was signed. The work was then transferred to the American University, and the co-operation between this bureau and the War Department for the study of nitrogen fixation has been continued since at the American University Fixed Nitrogen Research Laboratory. The three lines under investigation were the synthetic, or Haber process; the preparation and use of cyanamid; and the fixation of nitrogen by means of the silent discharge.

In the work on the Haber process the apparatus and materials in use at Arlington Farm were used for establishing a testing plant at the American University for testing catalysts at a pressure of 100 atmospheres.

Special investigation has been continued on the method of removing ammonia formed in this process from a mixture of hydrogen and nitrogen gases. The ordinary method of removing by liquefying the ammonia on cooling results in the gases leaving the cooling chamber carrying about 1 per cent of ammonia. As these gases lead to the catalyst chamber, the efficiency of the catalyst is greatly reduced. The effort has been to develop a method for more complete removal of ammonia.

A study has been made of the use of several solids of high absorptive capacity for this purpose, and promising results have been obtained. In addition, a study has been made of several liquids which have a high absorptive capacity for ammonia. Vapor pressure studies indicate that some of these liquids may be used with success. A small, semicommercial unit for the testing of these ab-

sorbents has been constructed, and a study of them is now being carried on with the use of this apparatus.

The method of granulating cyanamid was studied and improvement indicated in the preparation of a product less objectionable for fertilizer use.

Work on the silent electric discharge has been largely of a theoretical and scientific nature, involving the energy requirements of fixing nitrogen by this method. The progress of these lines of work has been announced in the scientific press from time to time during the year.

#### PHOSPHORIC ACID INVESTIGATIONS.

The regular investigations of the resources, production, consumption, and movement of phosphates and phosphatic fertilizers were continued throughout the year. The bureau kept in close touch with recent developments and newly reported discoveries of phosphate minerals and as far as possible examined the merits of new processes proposed and patented for producing phosphatic fertilizers. Much of this work is included in a paper published annually in one of the technical journals.

The broad phosphate problem, however, on which the bureau expended most of its time and energy was the investigation of furnace processes for volatilizing and collecting phosphoric acid in the concentrated form. These processes, which were devised mainly as the means of conserving the immense quantities of phosphatic material annually lost in preparing Florida rock for the market, have reached the stage where they hold out promise not only as a possible means of eliminating great losses of phosphoric acid incident to present mining methods, but also as an economical way of utilizing large deposits of relatively low-grade phosphates now regarded as of little commercial value. In addition highly concentrated phosphates can be produced by these methods, which will tend to offset the greatly increased cost of handling and transporting fertilizer materials.

The bureau has already shown that the electric furnace can be successfully employed in bringing about volatilization of phosphoric acid and was the first to demonstrate by actual experiment the feasibility of using the Cottrell precipitator as a means of collecting the phosphoric acid thus evolved. This work was carried to the point where private enterprise was convinced of its value and a number of installations are now in successful operation.

Efforts are now being made to lower materially the cost of production and thus greatly widen the use of furnace processes by showing the feasibility of employing fuel instead of the electric current for bringing about the volatilization of phosphoric acid.

Much progress has been made on these investigations during the year. Many of the chemical reactions involved have been worked out and the problem of briquetting finely divided phosphates and thus rendering them suitable for furnace treatment has been successfully solved. Both laboratory experiments and those conducted on a semi-commercial scale have definitely established the fact that a nearly complete volatilization and recovery of phosphoric acid from mixtures of phosphate rock, sand, and coke can be brought about at the temperatures attained and under the conditions existing in a fuel-

fed furnace. Had investigations been conducted no further it is considered that the proof of this one point, which was never established before, would have justified the money expended on this problem. The experiments, however, are now being conducted on a much larger scale with a view to showing the commercial practicability of the process. A furnace of semicommercial size (capable of handling over 1,000 pounds of material per day) has been constructed at Arlington Farm, Virginia, and the auxiliary equipment necessary for collecting the dust and burning the combustible gases evolved, and for the recovering and collecting of the phosphoric acid produced has also been erected. With this furnace the bureau has already made a number of tests which have yielded interesting and valuable data and enabled it to solve many of the mechanical difficulties and details of operation. The results obtained make it possible to plan intelligently the form of a larger installation which it is believed will definitely prove the commercial feasibility of this new process. The work, however, has reached a stage where a statement can be made, partly on experimental evidence, and partly on theoretical considerations, which will give a rough approximation of what may be expected of this new process.

In the first place the utilization of "mine-run" material will not only eliminate largely the tremendous losses of phosphate and thus prolong the life of our phosphate deposits, but will also render unnecessary many of the elaborate and costly plants for cleaning and preparing the phosphate rock for treatment with sulphuric acid in the manufacture of acid phosphate. These points, when taken in conjunction with the fact that a concentrated product can be obtained capable of standing the expense of long shipments and the great increase in handling charges, should more than offset the added expense, if any, of using fuel as a reagent in place of sulphuric acid. It is evident from the results so far obtained that the operation of smelting the phosphatic charge used for the production of phosphoric acid is similar to that of smelting the charge usually employed in a blast furnace for the production of pig iron, and on this basis the process appears most promising. While in the production of phosphoric acid by the furnace treatment nearly twice as much material must be heated to a smelting temperature in order to produce a ton of phosphoric acid as is required in the production of 1 ton of pig iron, nearly all of the heat units except those lost in the slag and from radiation through the furnace walls can be recovered and returned to the system. In the production of pig iron, on the other hand, much heat is consumed in reducing the iron to the metallic or marketable condition, and the heat thus consumed is not recovered. Moreover, the value of phosphoric acid per ton for fertilizer purposes is over four times as great as the value of pig iron per ton.

The final proof of the commercial practicability of these furnace processes, however, must rest in a plant of commercial size. The construction of such a plant is quite costly and a relatively large force is required to operate it. While a number of outside interests have signified their willingness to assume in part the expense of this larger installation as soon as the experiments have reached the stage where such an expenditure is warranted, it is not possible



for the bureau to pursue these investigations to the point where commercial success is finally assured without additional funds.

Numerous problems have arisen in connection with these investigations which have broadened their scope considerably; for instance, the practicability of using other types of furnaces; the use of various kinds of fuel; the best methods of furnacing the different classes of phosphate rock; the purification of the phosphoric acid obtained and the most economical form in which to market this acid; the collection of fluorine compounds evolved in the process and the practicability of rendering the slag obtained of marketable value.

The phosphate work, therefore, requires not only a much enlarged personnel but considerable equipment of a costly nature, and adequate provision should be made for the study of this broad problem of utilizing to the best advantage our resources of phosphates and phosphate minerals in a separate item in appropriating for the work of the bureau.

#### POTASH FROM CEMENT PLANTS AND BLAST FURNACES.

In previous reports reference has been made to work carried on by the bureau on the recovery of potash from silicate rocks. As a result of these investigations it was concluded that the most promising methods for recovering potash from this source consists either in igniting the rock with limestone as in the manufacture of cement, or in digesting the rock with free lime and water under pressure. In the first process, the potash is volatilized and passes from the kilns in the process of burning, while in the second it passes into solution during the digestion. In both cases the residue is suited for the manufacture of cement or other building material. At the present time these two processes are both being developed on an industrial scale, and of the numerous methods that have been tested out during the war these alone are the only ones, so far as known, that are now being operated commercially for the extraction of potash from silicate rocks. This result would thus seem to justify the conclusion reached by the bureau as an outcome of the investigations made.

In a survey that was made of the cement industry by this bureau it was found that the total potash that escapes from all the plants of the country, as at present operated, amounts to about 87,000 tons of  $K_2O$ . Separate estimates were also made of the potash that escapes from each individual plant. Installations have since been placed in a number of these plants for the recovery of potash, and in every case the quantity that was found to escape from the kilns checked in a remarkable way with the estimates that have been made by this bureau. There is, therefore, every reason to assume the reasonable correctness of the total estimate made for all the plants of the country.

The total potash collected from cement plants in 1917 amounted to 1,621 tons, but in 1919 the production was only 1,250, or about 1 per cent of the total that is lost in this industry. The decrease in the production in 1919 was due to unforeseen difficulties which developed in the collection of the potash and in preparing it in a marketable condition. It was found, for instance, that the percentage of potash

in the dust collected at some plants is too low to justify leaching the material or shipping it as such for direct use as a fertilizer. In order that the potash in such plants may become available, methods must therefore be devised for increasing the potash volatilized or decreasing the dust that escapes with it; or the method of recovery must be so modified as to bring about a mechanical separation of the potash and the dust during the process of collection.

Very unsatisfactory progress has also been made so far in leaching the potash from the dust, as now collected in commercial plants. A method developed by this bureau has been tested out in the industry on a small scale with very satisfactory results, but so far the method has not been applied on an industrial scale.

A great many difficulties have also been encountered in collecting the potash-bearing dust as it escapes from the kilns, but judging from results that have recently been obtained with a modified type of installation it would seem that these difficulties are not insurmountable but simply require time and attention for their solution.

In a report issued last year by the Bureau of Mines it was predicted that the cement industry would shortly become the second most important source of American potash. There is every reason to anticipate that such may be the case, but until the difficulties such as have been enumerated are overcome little progress can be expected. Most cement concerns have neither the funds nor facilities for investigating potash recovery, and several companies that have already gone to considerable expense in an attempt to recover potash have now decided to cease operating along this line until the difficulties standing in the way of the successful operation of this phase of the industry have been solved by others.

The situation with regard to the recovery of potash from blast furnaces is very similar to that outlined for the cement industry. A survey of this industry, corresponding to that which was made for cement plants, is now being made by this bureau. The results obtained in this work and in large-scale experiments now being made at two plants in this country go to show that the percentage of potash in the dust that escapes from some blast furnaces is higher than that contained in the richest cement dust. It is thought, too, that potash can be recovered more economically from blast furnaces than from cement kilns, as other by-products may be recovered in addition to potash, and that the advantages gained from cleaning the gases may more than cover the cost of collecting the dust. The same problems, however, that remain to be solved in the cement industry are also to be met with in the blast furnace industry, and owing to the relatively small advance that has so far been made in the recovery of potash in the latter industry, it is probable that other difficulties now unforeseen are likely to arise.

It is generally recognized that the potash that escapes from the kilns and furnaces of these two industries would, if collected in marketable form, go a long way toward supplying the normal consumption in this country. Since this is the case, there would seem to be ample justification on the part of this bureau, particularly in view of work that has already been accomplished in this field, in making a reasonable expenditure for the investigation of such phases of the problem as would properly come within the activities of this bureau.



## CONCENTRATED FERTILIZERS.

The principal nitrogenous materials that have hitherto been used in the manufacture of fertilizers are (1) organic ammoniates, as cottonseed meal, dried blood, and tankage; and (2) inorganic compounds, as nitrate of soda, cyanamid, and ammonium sulphate. During the last few years a marked change has taken place in the relative proportions in which these materials have been used in fertilizers. Many of the organic materials which were formerly used only in fertilizers are now extensively used as feed for stock, and as such command a price much in excess of that quoted for a corresponding quantity of nitrogen in the inorganic compounds. The result is that the organic ammoniates to-day are hard to obtain for fertilizers, and the future offers no prospects of any later increased production at all in keeping with the present rate of increase in the use of fertilizers. To supply the increasing demand for nitrogen materials, recourse must therefore be had to the inorganic compounds.

Under the stress of war conditions the War Department has erected a great nitrogen plant at Muscle Shoals, Ala. The primary product made at this plant is calcium cyanamid. This product has been used as a fertilizer to some extent for a number of years, but on the whole with rather unsatisfactory results. It can only be mixed in small proportions with the ordinary form of acid phosphate without causing reversion of the latter. The Muscle Shoals plant is equipped to convert the nitrogen of the cyanamid into ammonia, which in turn may be changed into the nitrate, sulphate, or phosphate. In this way there may be obtained a neutral compound having properties entirely different from the original cyanamid. The last of the compounds mentioned—ammonium phosphate—has a distinct advantage for use as a fertilizer over the other two, in that it contains two fertilizing elements combined in the same compound. For its preparation there is required phosphoric acid, and it fortunately happens that this is the form in which phosphorus is produced in the new processes that are now being developed for the more economical utilization and conservation of our phosphate deposits.

The attention which this bureau is now giving to the question of phosphoric-acid production is referred to in another section of this report. In previous reports an outline was also given of a new method that was developed by this bureau for the recovery of phosphoric acid as volatilized from an electric or other furnace, and it has been shown that the form in which the acid is collected by this process is eminently suited for combining with ammonia such as will be produced at the Muscle Shoals plant. This method for collecting phosphoric acid is now being used by an industrial concern in the South, and another concern is now making preparations to use the same process with the electric furnace in the production of phosphoric acid on a much larger scale, with a view to its use in the direct combination of ammonia prepared from cyanamid.

It is thus seen that owing to the present and anticipated future scarcity of fertilizer materials active steps are now being taken for the preparation of new materials of a concentrated nature which have not hitherto been used in fertilizers, or used very little. From a theoretical point of view these materials are admirably suited for



fertilizer use; and as they contain the fertilizing elements in a much more concentrated form than the relatively low-grade materials which constitute the bulk of our present-day fertilizers, a very great economy in the matter of transportation may be effected by their use.

It is a fact, however, that the chemical and physical properties of these compounds, particularly as relates to their suitability for fertilizer application, are but little understood, and this is especially true as regards mixtures of these compounds. The urgent need of a careful investigation of this subject, with a view to preventing, as far as possible, the loss of time and money that has been experienced in the past in preparing other materials for use as fertilizers, can not be too greatly emphasized. It is therefore desirable that a complete study be made of (1) the chemical and physical properties of the compounds and their mixtures which it is proposed to use in the manufacture of fertilizers, (2) the compatibility of these compounds in mixture, (3) limits within which they may be mixed without appreciable alteration in composition, (4) properties which interfere with their storage, handling, and transportation, (5) methods for obviating such properties as far as possible, and (6) suitable methods of application.

The preliminary work done by this bureau on this subject is described in the scientific press and in several patents that have been granted on certain phases of the work. Apart from this it would seem that none of the problems outlined have yet received any considerable attention.

#### EXPERIMENTAL KELP-POTASH PLANT.

The experimental kelp-potash plant, located at Summerland, Cal., began operations in a small way during the fiscal year 1918. During that year dried kelp and kelp char were produced and sold on their potash content to the extent of \$26,000, and studies looking to the improvement of processes and the availability of by-products were begun. During the fiscal year 1919 the production of dried kelp and char was continued, the amount derived from the sale of these two products covering operating expenses over considerable periods of the year. In addition, the steady production of high-grade potash salts was accomplished. Experiments were also undertaken looking to the manufacture of high-grade bleaching carbons for use in sugar refining and in the removal of coloring matter from a variety of organic liquids and solutions not susceptible to chemical bleaching, for which there is a very large and remunerative demand.

The end of the fiscal year 1919 found this plant and organization at the end of its second year of operation. At that time kelp was being dried, incinerated, and partly activated for the manufacture of bleaching carbon, followed by leaching for the extraction of potash and iodine, and partly leached without activation. The brine resulting was being evaporated for the manufacture of potassium chloride of about 80 per cent KCl content, and the portion of the carbon which had been activated was being extracted and further processed for the manufacture of bleaching carbon. The progress made in the various lines of activity during the fiscal year just closed is discussed in the following paragraphs.

The funds available for the past year's work were meager, since they failed to provide for the developments that we had in mind during the preceding year and absolutely failed to consider the rise in price of all sorts of commodities and of labor, which rise, of course, could not be foreseen when the appropriation was decided upon. As a consequence, it was necessary first of all to curtail expenditures wherever that was possible; and since expenditures for labor were the greatest to be incurred, it was there that economies were principally to be effected. Accordingly, the personnel was reduced to the lowest possible figure, and elaborations of process and investigation were promptly discontinued. The plant was operated through the year on the most conservative and economical basis possible, and yet make any progress at all. The progress recorded, therefore, is that which was accomplished in spite of the most adverse conditions with respect to funds, scarcity of labor and all sorts of commodities, high prices, and a radically deflated market for the main product yielded, potash.

The results accomplished on the extraction of potash have been very encouraging during the year. The output has steadily climbed upward, while at the same time unit cost of production has moved downward. The increase in efficiency during the year may be illustrated by a comparison of the record for June, 1919, with that of the same month of the present year. During the former month 892 tons of wet kelp were dried at a cost of \$20.47 per ton, and during the latter 2,136 tons, at a cost of \$9.72 per ton, a decrease in cost per ton of \$10.75. This increase in efficiency makes the drying capacity equal the harvesting capacity of the *Joseph Priestley*. In fact we should be justified in using the larger harvester, *Mayflower*, in place of the *Joseph Priestley*, if it were not for the difficulty of handling the larger boat steadily in rough weather, particularly during the winter.

During the year little progress was made in the destructive distillation of kelp, since there were no funds available for the construction of suitable retorts, so the incinerator installed formerly as a makeshift apparatus was kept in continuous operation throughout that period.

The lixiviator for extracting potash and iodine from char and the preparation of brine for evaporation operated throughout the year without a hitch and without trouble, requiring the attendance of only one operator for one shift, the lixiviator handling in one shift the entire output in char of the incinerator operating three shifts.

The evaporator throughout the year was operated two shifts a day, requiring a force of two operators. Improvements in equipment and operation have reduced the time for operating the evaporator by at least 50 per cent, which will be reflected in a lower production cost for the coming year. The output of potash salts is now approximately 2 tons per day of 80 per cent muriate. A ready market has been found for all the products, which are being sold on a contract running to December of 1920. Sales of potash during the year netted a gross return of some \$50,000. The problem of producing a bleaching carbon on a large scale has been successfully met during the year. Because of the necessity of acid-proof apparatus in the extraction of the carbon with hydrochloric acid and the lack of funds to secure such apparatus made of metal there was constructed a system of

leaching troughs and vacuum filters made up of wood, rubber, and lead. The apparatus, although a makeshift, has worked splendidly, from the first has shown large capacity, and has been operated by one man. A building has been constructed which now contains the entire char-treating apparatus, measuring and extracting tanks, filtering presses, and drier, with accessory equipment. The retort capacity for activating carbon has been doubled by the erection of two furnaces with four retorts. With this equipment, however, the retort capacity is still less than 50 per cent of the total quantity of char available for activation. Difficulties involved in the operation of these retorts have shown it advisable to devise some other method of activation. After months of experimentation on the laboratory scale, an electric furnace was designed and is now being installed, which it is believed will represent the solution of the problem of activating carbon on a large scale.

Carbon products produced in the laboratory furnace of this design showed an activity of about five times that of the products handled by the retorts. Three grades of bleaching carbon, called Kelpchar, grades Nos. 1, 2, and 3, have been produced. Grade No. 1 is that which was turned out in small quantities from the electric furnace and which has an activity of some five times that of Norit. Grade No. 2 is that which is now produced, approximating the activity of Norit, and accordingly being only one-fifth as active as grade No. 1. Grade No. 3 is that which was prepared with the use of sulphuric acid instead of hydrochloric, and being heavily loaded with calcium sulphate, it is naturally less active, pound per pound, than grade No. 2.

The grade of material now obtained varies from 75 per cent to 100 per cent on the basis of Norit, 100 per cent. Sales are being made at 25 cents per pound. This grade of carbon has had a favorable reception, and we could have sold it in large quantities if we had had it to sell. Samples sent out to various prospective users in many cases elicited high praise and requests for opportunities to purchase. We were not able to meet the demand, however. The apparatus installed has a capacity of 400 to 600 pounds active carbon a day, depending entirely on the output of the activating retorts. This at 25 cents per pound represents a daily revenue of \$100 to \$150. The successful operation of the electric-furnace installation should bring this daily output promptly to 1,000 to 1,500 pounds per day.

Laboratory researches carried on throughout the year on Kelpchar have shown it to have a wide range of applicability, being a highly efficacious bleaching agent for molasses, such as is used in the manufacture of yeast and vinegar; for malt sirups, the modern product of reconstructed breweries and distilleries; dye intermediates of many sorts; edible oils; crude lactic acid; and various other commodities. In some cases purification by bleaching carbon in a single operation has resulted in a better product than was formerly obtained by repeated and expensive crystallizations. This is especially true of certain dye intermediates, and it is confidently predicted that a good grade of bleaching carbon of standard properties supplied to the American chemical trade in substantial amounts at an equitable price will play an important rôle in the development of American chemical industries.



Toward the end of the year efforts were made to put iodine on a production basis. Apparatus has been constructed and put in operation. Methods of production are being rapidly improved and standardized. A substantial revenue is expected from the sale of iodine during the coming year. Cooperative researches on the distillation products from kelp have been arranged for in several laboratories. Dr. A. S. Wheeler, professor of organic chemistry of the University of North Carolina, is making a study of the neutral oils obtained from kelp tar. Dr. Fred H. Rhodes, of the Barrett Co., is investigating the kelp-tar acids or phenolic bodies. Dr. L. H. Duschak, of the Bureau of Mines, has made tests with crude kelp oils, redistilled oils, and kelp acids as flotation agents in the concentration of a variety of ores. The results have shown the oils to possess high potential value as flotation agents. Their commercial practicability will depend on the cheapness and uniformity with which they can be manufactured. The production of ammonia remains undeveloped, although problems in connection therewith have been studied throughout the year.

The study of forms of retorts for the destructive distillation of kelp continued throughout the year with a view to the construction of such retorts immediately on the beginning of the new year. Materials for this construction have been purchased, and that work will be pushed to the earliest possible completion. Slot retorts will be built and a full equipment of tar condensers, gas scrubbers, and ammonia liquor recovery apparatus will be installed. It is not expected by this installation entirely to solve the problems involved in the utilization of distillation products, but it is believed that we have gone far enough now to enable us to build retorts which will handle the plant's output of dry kelp in a convenient and economical manner. We are anxious to see this installation completed, among other reasons, on account of the final solution of the dust and smoke problems which it will undoubtedly represent. The completion of the electric furnace and of the dry kelp retorts represent the two big problems to be rushed to completion. They should represent economies in both materials and labor.

Complete cost data in the various processes have been kept. Curves representing the various operations have been plotted which show in each instance material progress toward more efficient operation. It has been necessary to reduce the operating force, but this has been done without the necessity of suspending any operations.

Plans for the new year contemplate the development of the output of bleaching carbon to not less than 1,500 pounds per day. This will be followed by the construction of new retorts for the destructive distillation of dry kelp, and, as our understanding makes it possible, the installation of apparatus for the proper and most advantageous treatment of the distillation products, namely, ammonia, neutral oils of various gravities, tars, acids and phenolic compounds, pitch, and combustible gas. Most of the supplies for this installation likewise have been purchased.

In order to save the last of the potash which remains in the char as it emerges from the lixiviator, a third vacuum filter of the type already installed is being put in place, which will make the lixiviator three stages, countercurrent, instead of two stages, as at present.

This additional apparatus, costing only a modest sum, will, in the course of the year's operation, cause a material saving which will amply compensate for the slight outlay.

New plans for handling the kelp char by quenching the char as it comes from the incinerator and subsequently handling by means of pumps and pipe lines will eliminate the disagreeable smoke and dust now produced in the operation and will also effect a decided economy through the elimination of labor.

A great increase both in the cost of labor and of materials has added greatly to the difficulties of working out a commercial process, but in spite of serious handicaps encountered, material progress has been made toward the solution of the problem of profitable manufacture of potash from kelp. That solution is now within our grasp. It only remains to increase the efficiency of processes already worked out and installed to put the plant on a profit-yielding basis, to make it yield a revenue in excess of the gross expenditures. Since expenditures in this experimental plant are much greater than they would be in a commercial plant devoted exclusively to production with thoroughly understood and standardized processes, this test of the feasibility of the kelp-potash proposition should convince the most exacting. There is no reason to anticipate now any failure to put this enterprise promptly on a profit-yielding basis. At the same time, I do not wish to overminimize the tasks in hand. They are difficult, but not as difficult as problems heretofore met and successfully solved.





## REPORT OF THE ENTOMOLOGIST.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF ENTOMOLOGY.

*Washington, D. C., September 7, 1920.*

SIR: I submit herewith a report of the work of the Bureau of Entomology for the fiscal year ended June 30, 1920.

L. O. HOWARD,  
*Entomologist and Chief of Bureau.*

HON. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### CEREAL AND FORAGE CROP INSECT INVESTIGATIONS.

The work of this section, continued under the direction of W. R. Walton, has been very important.

EUROPEAN CORN BORER.—During the year the aspect of the corn-borer problem has altered greatly. When the last annual report was prepared the area of infestation in eastern Massachusetts was known to be about 1,000 square miles, but as the season progressed the larger force of scouts and more thorough work, made possible by the appropriation of \$250,000, which became available July 24, 1919, resulted in the discovery of the insect throughout the Cape Cod peninsula. It was discovered also in outlying districts in Massachusetts and New Hampshire, where it was not previously known to occur. The infested area on the Atlantic coast at the end of the growing season of 1919 was about 2,000 square miles, and this has been still further increased during the last few weeks by the added area of several towns in Massachusetts contiguous to the old area. In the meantime the infestation in eastern New York has been found to include at least 1,000 square miles of territory in the counties of Fulton, Saratoga, Montgomery, Schenectady, Schoharie, and Rensselaer. During the month of September, 1919, a new area was discovered at the extreme western end of New York State, bordering on Lake Erie. Before the close of the season this infestation was found to include at least 500 square miles of territory. At about the same time a small infestation was located in Erie County, Pa. Both of the newly located infestations were in localities where broom factories existed, and which were known to have used imported broom corn. All the evidence so far accumulated indicates that these latter infestations were of several years' standing. The arrival in New York Harbor during the last few months of two shipments of broom corn from Italy which were found to be infested with both larvae and pupæ of the pest indicates almost conclusively the manner in which the insect was originally introduced from Europe. Investigations made by the writer in Italy during June, 1920, indicated

that the earlier idea, that the insect had been imported in hemp, was surely erroneous. The rotting of the hemp before baling, according to the methods used in Italy, would without doubt destroy all insect life.

The extension of the infestation as described above vastly complicated the problem and, of course, necessitated a greatly increased expenditure for scouting and quarantine purposes. In view of this more serious aspect of affairs the Secretary submitted on December 12, 1919, a supplemental estimate calling for an appropriation of \$500,000, the entire amount of which was to be immediately available, but Congress did not respond and the original appropriation of \$250,000 became exhausted by the spring of 1920. This suspended the control work until June 7, 1920, when a new appropriation became available. By this time the adult insects had begun to issue, thus causing the abandonment of an extensive control experiment which was being conducted over an area of some 60 square miles in eastern Massachusetts. The delay in granting the appropriation also prevented extensive efforts at control in western New York, which had been planned by Federal and State forces. An appropriation of \$400,000 became available June 7 of the present year, and a large force of workers was at once thrown into the field, principally for the purpose of scouting for possible new infestations and for the enforcement of the quarantine regulations.

As a result of the research work conducted during the year it has become apparent that the European corn borer has but one generation annually in New York, in contrast with the two generations occurring in New England. This fact indicates that the pest in all probability will prove less injurious in New York than in Massachusetts. In fact, the injuries inflicted by the insect in its New York environment as yet are comparatively slight. The chief danger to be feared from this situation is the possibility of spread to the great corn-growing States immediately to the westward of the present westward limit of infestation, and also to the southern half of the corn belt, and every effort is being made to prevent the artificial transportation of the pest to these areas. Flight experiments conducted for the purpose of determining the possible rate of natural spread of the insect have shown a maximum flight of 3,900 feet. This distance may, of course, be increased by subsequent observations on the second generation of adults. It has been shown that the adults are capable of emerging through 10 inches of loose soil and through 4 inches of tightly packed soil, thus indicating the uselessness of plowing under infested material as a means of destroying the larvæ.

A rather surprising development regarding the habits of the insect was the discovery this spring of the egg clusters in large numbers on several garden crops other than corn, such as beets, rhubarb, and less numerous on celery, lettuce, romaine, rye, plantain, sorrel, wild mustard, witch grass, morning glory, and snapdragon, all of which are new host records for the eggs. The larvæ have been found quite numerous in the leaf stems of beets as well as in the vines and pods of garden beans. These discoveries have necessitated a more stringent application of the quarantine regulations as regards garden crops other than corn. In the experimental work conducted in eastern Massachusetts the larvæ of the pest have been found to

feed upon cotton to some extent. Whether or not the bolls would be attacked has not yet been ascertained, because the cool climate prevailing there prevents the production of bolls on the plants grown for experimental purposes. The fact that the insect has been shown to feed upon cotton seems to indicate increased damage in case it should eventually become distributed throughout the cotton-belt States. This probability is given added weight by the discovery that under optimum temperature conditions the insect may undergo its complete life cycle in 30 days, and thus produce several generations each year. In fact, Del Guercio of Florence, Italy, told the writer in June that there are three generations a year there.

Generally speaking, at the close of July of this year the infestation in New England appears to be not quite so heavy as during 1919, although some few fields are still heavily infested.

That the insect may be easily transported into new territory by flood waters seems to have been amply proved by the fact that pupæ which were submerged in water for three days produced adult moths.

At the time of writing a total of 197 men are employed in the control work.

During the year several efficient pieces of machinery have been evolved for the purpose of destroying in the field infested materials such as cornstalks and stubble as well as weeds. One of these is a crushing apparatus through which the infested material is run and which applies a pressure of 90 tons to the square inch and is capable of handling 12 to 15 tons a day. Two of these machines are at present in operation. Another efficient piece of machinery is an oil-spraying burning machine of high power, capable of burning a strip 12 feet wide at one application, and with which it is possible to treat 12 to 15 acres in one day per machine.

*Introduction of foreign parasites of the corn borer.*—During the early summer of 1919 a preliminary investigation was made of European conditions, and a trained observer was established at Auch, in the south of France, to study the native parasites and to send them to this country in the effort to establish them in the infested parts of Massachusetts. Three species of parasites were found, and one shipment arrived in the autumn and the parasites were liberated in eastern Massachusetts. In May, 1920, the writer went to Europe and visited the regions in which the corn borer occurs in Belgium, France, and Italy, and arranged for the study of the native parasites at several points. He found that in Italy especially, where corn is extensively grown, the corn borer was always present in the fields, but in small numbers, and that nowhere was it necessary to take measures for its suppression. This indicated the existence of natural control, and it was found that four species of native parasites are known to the Italian entomologists. Arrangements were made for the shipment of parasite material to the bureau's agent at Auch, for comparison with the forms occurring at that point, and if it is found desirable other small parasite laboratories will be started in the south of Europe.

*GRASSHOPPERS.*—Great numbers of grasshoppers, belonging principally to the species *Melanoplus atlantis* and *Camnula pellucida*, have continued to assail the crops in North Dakota. The northern and western counties have been most heavily affected, although consid-



erable damage has occurred in the Red River Valley. During July, 1920, the situation became desperate because the counties along the Canadian border, which were hard hit by grasshopper damage, had exhausted their funds in the previous year's efforts, and were without means to purchase supplies and labor with which to conduct the fight. In this emergency wheat growers and business men, as well as State officials, appealed to the Federal Department of Agriculture for aid. Unfortunately, no funds were available for the purpose of providing materials or labor, and, although the department summoned a grasshopper expert from the Pacific coast in order to assist in the fight, it was found that he could do little or nothing to aid the counties most in need of help. As a consequence of this condition, the spring wheat crop in several counties has been seriously reduced by grasshopper injuries. In the course of the summer's investigations it was determined that large numbers of grasshoppers were drifting northward across the Canadian border, and it is claimed that the excellent control work conducted by the Canadian Department of Agriculture was, at least in some cases, made futile by reinfestation from the American side of the line. Swarms of grasshoppers were several times seen flying from Canadian territory into the United States, although by far the heaviest flights were in the opposite direction.

The conditions as described above illustrate the great desirability of the provision by Congress of an emergency fund to be drawn on for the purpose of meeting similar emergencies in the future. The problem created by the flying of grasshopper swarms across the international border should be met by appropriate action on the part of the Governments involved and the provision of funds for this particular purpose.

Wherever funds were available for adequate control operations the results in North Dakota this year again demonstrated the efficiency of the poisoned baits as a most reliable means of grasshopper extermination, and great savings have resulted from their use.

**HESSIAN FLY.**—As predicted in my last report, greatly increased damage by the Hessian fly occurred during the year throughout much of the winter-wheat belt. The injury was notably serious in Illinois, Indiana, Ohio, and southern Michigan, while damage was recorded in Kentucky, Oklahoma, North Carolina, Maryland, Virginia, and New Jersey. In Kansas conditions were much more favorable, owing, it is believed, to a vigorous campaign for control waged by State and Federal authorities during the summer of 1919. Much of the early sown wheat in Indiana and Illinois was killed out during the winter by the weakening action of the pest. A cooperative campaign for control was inaugurated by State and Federal forces during the present summer, and is being pushed vigorously in Illinois, Indiana, and Ohio, which, it is believed, will result in the protection of the winter-wheat crop of 1921 in these States. A publication giving the methods of control for Indiana was prepared by the bureau representative in that State and published as a circular of the experiment station in May of the present year. A new Federal Farmers' Bulletin (No. 1083) treating on Hessian fly control was issued in March, 1920.

**ALFALFA WEEVIL.**—As a result of seven years of careful experimentation a method of spraying for the control of the alfalfa weevil

has now been perfected which it seems certain will safeguard the alfalfa crop from the inroads of this pest wherever properly applied. This method has been experimentally demonstrated in cooperation with local farm bureaus over an area aggregating some 4,000 acres in which the spraying operations were conducted by practical farmers. The average cost of the work was \$1 per acre, and with alfalfa hay selling at \$35 a ton it is easily seen that the cost is comparatively trifling. In one county alone local authorities estimate that the saving secured by this spraying method amounted to \$40,000 for a single season. A new *Farmers' Bulletin* (No. 1180) describing fully the methods mentioned is in course of publication.

**CHINCH BUGS.**—Considerable damage by chinch bugs was recorded during the early summer of 1920. The work of this well-known pest resulted in more damage throughout Missouri than had occurred since 1913. Greatest injury seemed to be centered in St. Louis County, and Federal experts were active in advising farmers regarding the most efficient methods of control. Many publications were distributed in the stricken region through the cooperative efforts of State and Federal men. Illinois and other Middle Western States also suffered considerable injury.

**ARMY WORM.**—Local outbreaks of the true army worm occurred during June of the present summer in Missouri and Illinois. The usual excellent control was secured wherever the poisoned bait and ditch barrier methods were used in a timely and proper manner. Department entomologists were active in giving out the required information in the infested areas. Fortunately no widespread outbreak resulted from the colonies which appeared in the States mentioned above.

#### STORED-PRODUCT INSECT INVESTIGATIONS.

The very great value of the work of this section of the bureau is strikingly shown in many ways. A noticeable instance occurred during the year when inspection and advice by the bureau's experts saved the Quartermaster's Department of the Navy supplies of rice and beans worth about twenty-seven times the appropriation for this project. Dr. E. A. Back continues in charge of this work.

**CORN WEEVILS.**—The research laboratory established at Orlando, Fla., for the purpose of studying the biology and methods of control of corn weevils, has been continued during the year. A large amount of new information has been secured regarding the biology of weevils and their parasites. Four papers containing new information have been presented for publication and one *Farmers' Bulletin* (No. 1029) giving practical suggestions for farmers along the lines of corn conservation has been published and widely circulated.

The office established at Athens, Ga., has been moved to Thomasville, Ga., in order that the expert in charge may more easily reach the important corn-growing sections of southern Georgia, where an intensive campaign has been carried on to take to the farmer, in cooperation with the extension service of the Georgia Agricultural Experiment Station, information regarding the preservation of corn from weevils. This work has proved very popular and has resulted in the construction of a large number of corncribs in which corn is being successfully treated with carbon disulphid.

**BEAN AND PEA WEEVILS.**—The investigations into weevil losses to California-grown beans and peas, started during the preceding fiscal year, has been continued at the Alhambra Laboratory. The work has consisted for the most part in research work in biology and cold storage. Two papers containing original data have been submitted for publication. This work has received the hearty cooperation of the bean growers and warehousemen of the Pacific coast, and while the investigations are not yet complete, they bid fair to be of great practical value.

**CONTROL OF INSECTS IN STORED MATERIAL.**—Experimental work to determine the usefulness of fumigation, electricity, heat, and cold storage have been continued during the year with a view of lessening or preventing the enormous waste of stored goods in warehouses. Though this work has suffered through the resignation of three experts during the year, the results already obtained promise an immense saving to the country when put into operation.

Work upon the commercial machine for sterilizing cartons of cereals by means of electricity has continued during the year under private direction. It promises results of value to the producers of cereal products.

**HOUSEHOLD PESTS.**—Investigations of household pests have taken the form largely of a dissemination of information to householders. A special study has been made of the black carpet beetle, and a paper has been prepared on this insect, giving new information. An outstanding feature of the work during the year has been the practical aid given to the Army hospitals in the suppression of pests.

**INSPECTION AND INTELLIGENCE SERVICE.**—The arrangement made during the war with the quartermaster of the Army at the port of New York, whereby the bureau has undertaken to make frequent inspections of food and clothing supplies, has continued to prove satisfactory, and is being extended to other depots not only of the Army but of the Navy. The purpose of this cooperation is to keep the Quartermaster Departments of the Army and Navy informed, through inspections made by bureau experts, not only of the condition of the food supplies purchased and delivered at the warehouses but also of their condition from time to time during the storage period. Such inspections detect and lead to the checking of insect ravages before the insects have had a chance to multiply and cause great loss. During the last few months the office and laboratory maintained at the Army supply base at Brooklyn, N. Y., has been closed as the result of the resignation of the expert in charge.

**TEMPERATURE AND HUMIDITY INVESTIGATIONS.**—During the year new research work was inaugurated to determine the effect upon insect development of varying degrees of temperature and humidity. Valuable equipment has already been secured and data new to science placed on record.

#### DECIDUOUS-FRUIT INSECT INVESTIGATIONS.

Investigations of deciduous-fruit insects have been carried out under the direction of Dr. A. L. Quaintance, as formerly.

**THE JAPANESE BEETLE.**—Further experience has shown that the Japanese beetle is almost omnivorous in its feeding habits, attacking many important crops, as apple, sweet cherry, grape, red clover,



corn, ornamental flowers, and certain shade and forest trees; that it is an active insect and a strong flier, spreading naturally with ease, and is readily carried by artificial means; that in the absence of its natural enemies it reproduces in almost incredible numbers; that conditions in the present infested area are ideal for the insect, in consequence of which it has continued to multiply and spread in spite of restrictive measures practiced. The insect has crossed the Delaware River near Riverton, N. J., and occupies on the Pennsylvania side a strip about 7 miles long and from one-half to  $1\frac{1}{2}$  miles wide. Its present area of distribution is approximately 50 square miles.

The various phases of the work carried out and under way in co-operation with the New Jersey State department of agriculture may be considered under the following divisions:

*Quarantine.*—A quarantine against the Japanese beetle was inaugurated in 1919 and included only sweet or green corn. Further experience indicated the necessity of extending the quarantine to all other farm crops, as well as nursery and greenhouse products, and such a quarantine is established and in successful operation at the present time. As a necessary basis for establishing quarantine areas, we have thoroughly scouted the territory to keep track of further spread. Much attention has been given to this scouting work, and the distribution of the beetle from week to week is pretty accurately known.

*Control.*—Increased funds permitted much more effective control operations than previously. To restrict the spread of the beetles attempt has been made to maintain a barrier band of dusted or sprayed foliage about a mile wide completely around the infested area. Within this band all food plants on headlands, along roadways, and elsewhere have been eliminated as thoroughly as possible. Despite effective work in keeping the barrier band well coated with repellents and poisons, indications are that the beetle will not be held by it, but will continue to spread.

Within the infested area we have encouraged the residents to adopt farm practices to destroy the insect in the grub stage. Systematic collection of beetles by hand has been followed, and great numbers have been destroyed. Much work has been done to destroy the grubs in the soil by the application of soil insecticides in the worst infested areas. Headlands and roadways have been kept as clear as possible of food plants by destruction with weed-killing chemicals, by fire and other means. This work is of considerable importance in minimizing the chances of distribution of the beetles on passing vehicles, by pedestrians, and otherwise.

*Investigation.*—Preliminary insecticide investigations were begun early. During the year just closed this work has been materially strengthened and a very large number of materials likely to be repellent or poisonous have been experimented with. Tests have been made with a large series of chemicals likely to prove attractive to the insects, and other lines of inquiry were followed. In consequence of the quarantine it became desirable to ascertain whether plants with earth balled around the roots could be so treated as to destroy any grubs present, and many experiments were made.

*Introduction of natural enemies.*—An experienced entomologist is now in Japan studying the natural enemies of the beetle, and it is

hoped that parasites or other natural enemies can be introduced and established in New Jersey. One sending from Japan of a predatory beetle has already been received.

PEACH INSECT INVESTIGATIONS.—Investigations of peach insects have been continued in Georgia, Mississippi, and Arkansas. Peach growers in Georgia last year suffered very heavy losses from the combined injuries of the plum curculio and brown-rot, which were notably more prevalent than in previous years. During the growing season of 1920, the curculio has been even more destructive, causing a heavy loss estimated conservatively at about \$2,000,000 for the State. Unusual weather conditions and other factors have so increased the abundance of this pest that treatments effective in its control during normal times were quite ineffective under the conditions which prevailed. There is some evidence that in the presence of abundant rains and high temperatures the curculio may develop a partial second brood of larvæ which infest the ripening fruit, causing an increased proportion of wormy fruit at harvest time. The inconspicuous character of the curculio egg punctures on the peach makes it difficult to detect infested fruit, and undesirable quantities may be gathered and shipped to the market in spite of the best efforts of the growers. The importance of the situation warrants a careful reinvestigation of the whole subject of curculio control in peach orchards in the South.

The work in Mississippi has been continued under more favorable conditions and the data obtained confirm previous conclusions that under average weather conditions dusting of trees with insecticides and fungicides is as effective in the control of the curculio as spraying. Large-scale experiments have been undertaken with arsenicals in the post-harvest treatment to destroy the curculio during the period over which they are supposed to be feeding in orchards and before they enter hibernation. The curculio population in treated and untreated blocks is ascertained by systematic jarring operations, taking records of the beetles caught.

Further experience with para-dichlorobenzene as a treatment for the peach borer indicates the effectiveness and safety of this treatment for this very serious pest. The use of this material is now being adopted by numerous orchardists, and no failures have been reported. In Arkansas an orchard of about 200 acres was treated last fall with para-dichlorobenzene, and large purchases of the chemical have been made for use in Georgia and other peach-growing districts during the fall of 1920.

APPLE INSECT INVESTIGATIONS.—*Codling moth*.—Life-history studies of the codling moth have been continued about as described in the last report, though work was undertaken in one new locality, namely, northern Georgia, to ascertain the number of generations and other life-history facts relative to the insect in this southern locality. The work on the codling moth in Colorado has been completed, and reports on life history and on experimental work in orchards are now in the course of publication. Information has been obtained on the effect of low temperatures on the insect; thus the winter of 1919-20 in the Rogue River Valley was the coldest in the history of the local station. This spring a large percentage of overwintering larvæ was found dead. The same experience was observed at Yakima, Wash.

Continued tests with the spray gun in orchards indicate its value as a permanent appliance in orchard spraying. When carefully compared with spray rods and nozzles there appears to be little difference in effectiveness, with a distinct advantage for the spray gun in rapidity of application. At the Delaware station attention has been given to the influence of packing sheds on the abundance of the codling moth; thus, in cooperation with several prominent apple growers, baskets used to harvest the apple crop of 1919 were kept over winter and spring in tight buildings. During the period of spring emergence of the moth hundreds of them appeared from cocoons spun in the baskets, but died in the buildings instead of escaping in the orchards as they do in most instances. This factor in codling-moth control is one that has not been sufficiently stressed, especially in view of the increase of packing houses in orchards. It will receive further attention.

Experiments are under way to establish, if possible, in the Yakima Valley certain eastern parasites of the codling moth, which are here of considerable value. Some shipments have already been made. In cooperation with the Connecticut Agricultural Experiment Station and certain other northeastern institutions, tests are being made with a three-in-one dust composed of a fungicide, arsenate of lead, and tobacco extract for the treatment at one and the same time of fungus diseases, biting insects, such as the codling moth, and sucking insects, such as plant-lice and red bugs.

In connection with studies of the codling moth, attention is also being given to numerous other apple insects, and valuable data have been accumulated on the life histories and the effect of various control measures. Among these are the apple maggot, cankerworms, certain leafhoppers, the apple curculio, etc.

Work with apple-tree borers which has been under way for some time is now nearing completion and publications have been issued or are in press.

GRAPE INSECT INVESTIGATIONS.—The investigations of the insect pests of the grape in northern Ohio have been continued in cooperation with the Ohio Agricultural Experiment Station, particular attention being given to the grape-berry moth. Additional data have been obtained on its life history and further experiments have been carried out in vineyards. Experience with the two-spray method of control confirms earlier conclusions that this plan is effective in preventing serious injury and in obviating almost entirely the presence of spray residue on the fruit at harvest time. Results obtained from a single spray confirm earlier results and indicate that in vineyards where the grape-berry moth is not seriously destructive one treatment with an arsenical, such as arsenate of lead, will be sufficient.

Complaint was received of the destructive occurrence in portions of the grape regions of Michigan of the grape rootworm and a species of plant-louse. Although these pests have long been present in this territory, their injuries there have heretofore been quite unimportant.

*Miscellaneous grape insects in the Ozarks.*—In connection with the bureau's laboratory at Bentonville, Ark., attention is being given to grape insects in the Ozark region of Arkansas and southern Missouri, in the latter State, in cooperation with the Missouri Fruit Ex-



periment Station. The life histories of the principal insect enemies of the grape are being investigated and remedial work is under way.

The development of a satisfactory means of control of the grape mealybug in California still engages the attention of an agent at Fresno. Further work with sulphur fumes as a treatment for this insect during the dormant period of the vines indicates that this is not a practical plan, and other methods are under investigation.

The white-lined sphinx moth occurred this year in several sections of Tulare and Kern Counties, Calif., in young vineyards. From all indications the caterpillars had been feeding in near-by grain and grass lands, and as soon as these were harvested or dried up they migrated to the young green vines. Several sprays were tried with but little success, as the insects were nearly full grown when discovered, though it was found that the insects could be collected readily by hand, one man being able to cover as much as 12 acres per day. The Achemon sphinx moth was also in evidence in Merced County, injury beginning about the 1st of June. About 1,200 acres were involved, and in view of the expense of spraying, the vines were dusted early in the mornings with a dust composed of 3 parts of sulphur to 1 part of arsenate of lead. This proved to be very effective, most of the insects dying within 24 hours.

CRANBERRY INSECTS.—The investigations of cranberry insects in Washington State in cooperation with the Washington Agricultural Experiment Station were concluded at the end of the growing season of 1919 and a report has been prepared. Very satisfactory results were secured in the treatment of the blackhead fireworm by three applications at intervals of 17 to 21 days between May 1 and July 17 of nicotine sulphate containing 40 per cent nicotine used at the rate of 1 part to 800 parts of spray, with the addition of fish-oil soap at the rate of 2 pounds to each 50 gallons of the liquid. Growers generally have adopted the treatment indicated and are securing satisfactory results in the control of this, their principal insect pest.

NUT INSECT INVESTIGATIONS.—*Pecan insects*.—Further experiments in orchards have shown that the pecan-leaf case-bearer is best controlled by a spray of arsenate of lead, as compared with an application of this arsenical in dust form; in fact, none of the various dusts were very satisfactory. It also develops that in the use of calcium arsenate in dust or liquid form considerable burning of foliage and of nuts resulted. It was found that the so-called obscure scale, frequently complained of on pecan, can be controlled by spraying with either crude-oil emulsion or lime-sulphur solution in winter strength applied during early spring before the trees bud out. Spraying and dusting experiments in the control of the pecan weevil were unsuccessful. On the other hand, fumigation of harvested nuts with carbon disulphid at the rate of one-half ounce of the fumigant per bushel of nuts, with an exposure of 24 hours, proved effective. This method is only partially successful, however, since a considerable portion of the larvæ in some regions leave the pecans before harvest time. A report on the pecan nut case-bearer, embodying information on its life history and control measures in the Southeast, has been completed. A publication on the pecan bud-moth is in preparation.

The investigations of pecan insects in the Southeast having been fairly well completed, it seemed desirable to transfer the work in the Southeast to Texas, which was done in June. Special attention in that State will be given to the pecan nut case-bearer, which is there very destructive, and also to the pecan weevil and other miscellaneous pecan insects.

*Miscellaneous nut insects in the North.*—The walnut husk maggot, which fed originally and still feeds extensively in the husks of black walnuts, is now attacking the husks of Persian and Japanese walnuts in the eastern part of the country. The maggots in great numbers mine through the husks, causing the nuts either to drop prematurely or to adhere to the branches beyond the regular harvest time. The shells of the nuts are also stained and soiled by the maggots. In several localities in Maryland and Pennsylvania very promising crops of Persian walnuts have been practically ruined by this species. A study of the life history, habits, and means of control of the husk maggot is under way and results will be ready for publication by the end of the season.

Several species of walnut and hickory curculios are also under investigation. These insects attack the immature nuts, causing many of them to fall. The walnut curculio attacks butternuts, Persian walnuts, and Japanese walnuts, causing the nuts to drop prematurely, and the grubs mine the tender shoots of the husks, frequently killing young trees. Another form, *Conotrachelus retentus*, lays its eggs in black walnuts when the nuts are about one-fourth grown, the larvæ causing the nuts to drop. By actual count it has been ascertained that in some localities from 50 to 90 per cent of the nuts are infested. The weevils attacking chestnut and hazelnut are also being studied. Choice varieties of our native hazel are being introduced by nursery-men and the present interest in growing hazelnuts makes a study of the hazelnut weevil important.

ORCHARD INSECTICIDE INVESTIGATIONS.—Investigations of miscellaneous insecticides have been continued. A comparative study of arsenicals as insecticides, in cooperation with the Bureau of Chemistry, has been under way during the past two or three seasons and includes a study of raw materials, methods of manufacture, analyses and classifications and physical properties of arsenicals, relative toxicity, amount of arsenic required to kill insects, and relation of soluble arsenic before being eaten and after being eaten by insects. This work has involved a very large amount of detail, requiring the feeding and examination of thousands of insects and careful recording of the actions of food. It appears that the percentage of water-soluble arsenic in the arsenicals before they are eaten by insects has little to do with the toxicity of these arsenicals, although with regard to those arsenicals in which the arsenic content is nearly all water-soluble the rate of toxicity is generally highest. As a rule, also, the higher the percentage of arsenic rendered soluble inside the bodies of insects, the higher is the rate of toxicity, and furthermore the more arsenic retained inside of the insects as compared with that voided in the feces, the higher is the rate of toxicity. Evidently only an indefinite opinion concerning the killing power of an arsenical can be inferred from its composition, but judging from both the chemical and insecticidal results obtained the toxicity depends directly upon

the amount of arsenic rendered soluble inside of the insects, and this solubility depends directly upon the stability of the compound. These comparative studies of arsenicals as insecticides are now nearing completion, and a report will be prepared at the close of the present season. Much experimental work has been accomplished with contact insecticides in an effort to find something to replace nicotine or tobacco extract. These studies have included testing of various fractions of mineral oils and a very large list of miscellaneous chemicals. In cooperation with the Bureau of Chemistry special attention has been given to organic contact insecticides and a compound has been discovered of the pyridine series which offers hope of success. Much work has also been accomplished in a study of the vitamins in insect nutrition as bearing on the food requirements and choice of food of insects. In addition to the foregoing investigational work the usual amount of testing proprietary and other insecticides in orchards has been conducted to keep the office informed on the merits of these as they appear from year to year.

#### VEGETABLE AND TRUCK CROP INSECT INVESTIGATIONS.

Investigations of the insects affecting vegetable and truck crops have been carried on under the direction of Dr. F. H. Chittenden, as heretofore.

**SWEET-POTATO WEEVIL ERADICATION AND CONTROL.**—Intensive work on this project has been continued, although handicapped by a shortage of funds. Since the infested area, comprising portions of six States, was well determined during the preceding year, efforts were restricted to actual eradication and to investigational work. In Florida very favorable results have been secured by cooperative clean-up measures with the farmers. This work has been closely followed by the inspectors, and where proper cooperation had not been shown by the farmers themselves, all old banks were burned and volunteer plants pulled from old fields. A close reinspection has been continued over the infested area. It is gratifying that no infestations outside of the original area have been found, 401 farms being under continual supervision. In cooperation with the State Plant Board of Florida, about a million weevil-free draws were distributed to 214 farms previously infested. It appears that the infested area in Florida and Georgia has been materially reduced and that marketable crops are being produced where three years ago sweet potatoes were annually rendered useless through weevil attack.

In Alabama 30 farms in a well-circumscribed locality were found to be infested, and careful clean-up measures were carried out, with the result that our inspectors have been unable to find a single weevil during the harvesting and planting season this year. It is accordingly believed that Alabama may now be declared weevil free. This will, however, be determined by a thorough inspection of the coming harvest.

In Mississippi activity has been similar to that in the more eastern States. Two hundred and thirty-two infested farms now remain. All of these were planted with weevil-free draws during the past spring, and it is at present impossible to judge definitely as to the actual reduction in infestation. Nearly one and one-half million



weevil-free draws were distributed in this territory. The indications are that a material reduction, both in the number of farms infested and in the seriousness of infestation, may be expected.

In Louisiana, owing to the extent of infestation and the absence of satisfactory legislation, eradication has not been attempted. A test is, however, being made of the application of approved cultural methods by interested growers in one of the more seriously infested localities. A high grade of neighborhood cooperation having been secured, it is expected that a material saving will result from the adoption of the processes recommended. Even though strict eradication measures have not been applied in the selected locality, work has been continued on the experimental eradication of wild food plants.

In Texas large-scale control projects and life-history work have been begun. More than 8,000 specimens have been carried separately through all stages possible.

In general, it may be mentioned that a weevil-free zone 30 miles in length is being maintained on the eastern coast of Florida through the destruction of the seaside morning glory, and that the only infested plot of this wild food plant on the mainland of Mississippi has likewise been destroyed. Preliminary or progress reports on the habits, life history, control, and eradication of this pest are in preparation and will soon be available for publication.

**INSECTS AFFECTING POTATO, TOMATO, AND ALLIED CROPS.**—The Colorado potato beetle has been the subject of investigation with especial reference to its scarcity in recent years in Maryland and Virginia. Late spraying, parasitism, and severe winter weather are powerful elements in holding this pest in check. Continued investigations of this problem are desirable. The potato leafhopper, which causes a condition known as "leaf burn" or "hopper burn" to potatoes in the potato-growing sections of the Northern States, is being carefully studied, especially in Wisconsin. Bordeaux mixture has proved a satisfactory repellent, while nicotine sulphate and kerosene emulsion, standard remedies for sucking insects, have been found ineffective. The tarnished plant-bug has been investigated to determine especially all of its wild food plants and breeding plants, a project of economic value requiring careful study in its extensive range. It has been the cause of severe injury to potatoes in some sections and has undoubtedly caused other damage without the source being known. Study of the spinach aphid and the potato aphid, important enemies of these crops, has continued.

**INSECTS AFFECTING BEANS AND PEAS.**—Injury by the bean ladybird in Colorado and New Mexico has continued with the exception of points where its control by spraying through the use of methods developed by this bureau has been adopted. A practically complete account of this insect in its western occurrence, in addition to an emergency Farmers' Bulletin (No. 1074), has been published. A threatening outbreak of this insect, the first of record east of the Rocky Mountain States, has just been reported from Jefferson and Bibb Counties, in Alabama, indicating that it is likely to become permanently and extensively established east of the Mississippi River. Since it will probably become as costly a pest on beans and cowpeas as is the Colorado potato beetle to potatoes, immediate action should be taken to effect its eradication.

There has been an unprecedented outbreak of the green clover worm over the eastern United States, particularly along the Atlantic seaboard, many fields of all varieties of beans being practically defoliated. This pest was found to be controlled readily on truck plantings by the application of suitable arsenicals. Studies of the pea aphid on the Pacific coast are being continued. The pea moth, recently introduced into the Northern States from Canada, has been studied, and it has been determined that it is not of European origin, as formerly believed, but new to science.

**CUCURBIT INSECTS.**—Although a practical treatise on the striped cucumber beetle and its control is available in the shape of a Farmers' Bulletin (No. 1038) recently issued, the insect is a difficult one to control and constant work is being done on it, especially in its rôle as a carrier of a cucurbit disease, in an endeavor to discover more effective methods for holding it in check. Certain repellents and poisons were tested during the year but found to be without value. The Bordeaux arsenate of lead mixture combined with other measures has proved the best means for its control. Work on such important pests as the melon aphid, the squash bug, and the squash vine-borer has been continued and results of an investigation of the squash bug are available for publication.

**INSECTS INJURIOUS TO CABBAGE AND ALLIED PLANTS.**—Extensive experiments have been under way on the Pacific coast against aphids affecting cabbage and other crops with the newly devised nicotine dust spray as a contact insecticide. A monographic account of the western cabbage flea-beetle, a pest of great importance west of the Mississippi River, has been completed and is available for distribution. Much attention has also been given to the study of the life history and habits of the other injurious flea-beetles which affect cabbage, turnip, and related crops. The false cabbage aphid was the cause of a severe outbreak on turnip, kale, and seedling cabbage in early spring in Maryland and Virginia. The attack was of such suddenness and severity that it could not be checked, and it ceased before control experiments could be completed. Preliminary work on the European horseradish webworm, which has been a pest for a number of years in Canada, has been carried on, especially in reference to its recent occurrence in Virginia, and similar preliminary work is being done on some other insect enemies of horseradish.

**SUGAR-BEET INSECTS.**—Work on the sugar-beet leafhopper, which causes the costly condition known as "curly top," has been continued. The nature of the disease and the importance of temperature, number of insects, length of feeding time, and other factors in its production are being investigated. It has been found that an interesting alternation of food plants, involving at least two wild species, occurs between the production of disease on sugar beets and reinoculation. Three hundred and fifty types of resistant beets selected from various California fields are being studied. The work at Greeley, Colo., involving the control of the webworms injurious to the sugar beet and investigations of the beet root-aphid, has been temporarily abandoned, owing to a reduction of appropriations. It is reported that serious injury to beet fields in eastern Colorado has resulted from lack of instruction as to control measures for the sugar-

beet and so-called alfalfa webworms. A comprehensive account of the beet leaf-beetle, an important enemy of beets of all kinds in the Western States, has been completed. This insect has practically the same distribution as the bean ladybird but appears to be decreasing in injuriousness.

OTHER TRUCK-CROP INSECTS.—A new enemy to strawberries, recently discovered in Virginia, an imported moth which works as a crown borer, is being investigated to determine its capabilities as a pest. Other insect enemies of strawberry, blackberry, and raspberry, especially the strawberry weevil and the leaf-rollers, have been studied, and accounts of some of the more important forms are available for publication. The minor insect enemies of the sweet potato have been the subject of similar investigation. The onion maggot has been under continual investigation in the hope that some more practical and inexpensive remedy than is now known may be discovered.

#### INVESTIGATIONS OF INSECTS AFFECTING FOREST RESOURCES.

The work of the Branch of Forest Entomology has been continued, as before, under the supervision of Dr. A. D. Hopkins.

In addition to the investigation of insects affecting the forest resources of the country, the allied subject of shade trees and ornamental shrubs received some attention. While the forest resources represent an indispensable need of the Nation and are an item of pecuniary wealth, the shade trees and ornamental plantings of parks and streets, grounds of health and pleasure resorts, public institutions, and city, suburban, country, and farm homes represent a form of wealth which the people realize in health, recreation, enjoyment of the home, and increased value of property.

PRINCIPAL DEPREDACTIONS OF THE YEAR.—In addition to the usual damage by insects to forest and shade trees and forest products, which amounts, in reduced values and direct losses, to more than \$100,000,000 annually, there has been no conspicuous increase in the more destructive insects except that of the spruce budworm in the spruce forests of northern New England, which has been the source of considerable alarm to the manufacturers of paper pulp and the publishers of newspapers; a defoliating worm affecting large areas of pine in Texas; and a threatened outbreak of the southern pine beetle, which is the worst menace to the pine forests of the Southern States. The defoliation of the Sitka spruce of the Oregon and Sitka coasts by plant-lice and caterpillars has been the subject of special inquiry. The dying of elms in the Mississippi Valley and of oaks in the Southern States has attracted much attention, and there has been a decided increase in the requests for information about insect damage to shade trees. One of the most remarkable losses of a serious nature has been that caused by a wood-boring beetle to lead telephone cables in California. Damage by wood-boring insects to ash lumber for the manufacture of aircraft at the Philadelphia navy yards was the subject of investigation and recommendation. Sixty-eight cases of damage by white ants or termites to buildings and contents were reported from 21 States, 3 Territories, and the District of Columbia. Some of the notable examples in Washington City were damage to and in the new Bureau of Engraving and



Printing, where Government bond paper and postage stamps were destroyed; damage to the woodwork of one of the new buildings at the Soldiers' Home; continued damage to the floors of the old National Museum building and to stored material; damage to the greenhouses and plants of the War Department and to the dwelling of the Secretary of War. Serious damage to fruit trees and vegetable crops by these insects was reported from California.

The damage to crude forest products by wood-boring insects continues to cause extensive losses throughout the forested sections of the country where logging operations are carried on.

PRINCIPAL LINES OF INVESTIGATION AND RESULTS.—The principal lines of investigation carried on during the year have included the continuation of an intensive study of the character and extent of the damage caused by tree-killing barkbeetles and methods of controlling them in some of the principal national and private forests of the Pacific slope and Rocky Mountain regions.

In southern Oregon a study was made of the causes of the natural increase and decrease of the western pine beetle, including records on 2,549 trees, representing a volume of over 2,000,000 board feet. It was found that the average killed tree was attacked by 2,070 beetles, which deposited over 74,000 eggs in the bark, but that only about 30 per cent of these developed to the beetle stage. It was also found that out of the number of beetles that develop in and emerge from the trees killed by them, only about 3 per cent survive to continue the attack on other trees. This furnishes important evidence as to why the percentage principle of control is successful, for this 3 per cent survival is still further reduced in attacks that fail and by natural enemies and other natural causes until there is a much smaller percentage to congregate in sufficient force to continue the killing of trees. Thus in artificial control, by which a sufficient percentage of the killed trees are treated to reduce the numbers of the beetles below their power of concentration in sufficient force to overcome the natural resistance of the living trees, the beetles cease to be a menace and the problem is solved.

Inspections during May, 1920, of the area in the Middle Fork basin of the Sequoia National Park, where control work was conducted by the National Park Service, the Forest Service, and the Bureau of Entomology, showed that, while 1,055,000 board feet of yellow pine and sugar pine timber had been killed by beetles in 1917, the treatment of 52 per cent of the volume of the infestation in 1918 was followed by a decline of 71 per cent in the total loss of the preceding year. In the yellow pine alone 60 per cent of the infestation was treated and the subsequent decline amounted to 81 per cent.

Experimental trap tree work was carried on during the summers of 1919 and 1920 in the Marble Fork and Cactus Creek Basins of the Sequoia National Park at a cost of \$500. As a result both basins are now free from evidence of any serious infestation.

A detailed study of the character and extent of depredations by tree-killing beetles in the pine forests of California, as represented by Federal Forest District 5, shows that during one year, 1917, approximately 90,000,000 board feet of yellow pine and sugar pine were killed by the western pine beetle and mountain pine beetle.

This represents a stumpage value of \$270,000. It is estimated by forest officials and representatives of the Bureau of Entomology, who are in a position to have intimate knowledge of the subject, that this amount represents the average annual loss during seven years, 1912-1919, which would represent a loss of 270,000,000 board feet of merchantable timber with a stumpage value of \$2,340,000. During this period, owing to lack of funds, it was possible for the Forest Service to expend but \$60,000 toward the prevention of this great loss of forest resources. Through a completely organized cooperative arrangement between the Forest Service and Bureau of Entomology, 130,000 acres within the San Joaquin drainage in California, with a stand of 1,507,500,000 board feet of yellow pine and 682,500,000 board feet of sugar pine, were covered by control work in 1920, and the work of maintaining control will be continued during a period of five years. One of the objects of this project is to make a thorough test of the percentage principle and other methods of control that are recommended by the Bureau of Entomology. An area of 24,000 acres will be left without treatment to serve as a basis of comparison with the treated area.

The application of the newly-discovered "Craighead solar heat principle" of insect control, in connection with work against the western pine beetle in California, has shown that a maximum daily temperature as low as 75° F. during a few clear days will kill the broods of beetles in the infested bark removed from the trees and exposed to the direct rays of the sun. This method renders it possible to continue control work during the summer months which heretofore could not be done by the method of burning the bark owing to fire hazard.

Extensive reconnaissance and intensive studies are being made in the Coeur d'Aléne National Forest of northern Idaho, where, in 1913, over 4,000,000 board feet of merchantable white pine timber was killed by the mountain pine beetle. The area to be covered by the investigations is over 348,000 acres, including 80,000 acres of yellow pine, with smaller areas amounting to 5,000 acres for the intensive studies.

The extensive experiments conducted at our field station in southern Arizona during the last five years, to determine the time of year to cut mesquite for fuel and other required local products to avoid destruction of the wood by insects, have been completed and the fact has been demonstrated that if mesquite is cut for cordwood, posts, etc., between October 15 and January 15 in southern Arizona and piled in open ricks, little or no damage will be caused by insects. This result is of great economic importance to the residents of all sections of this and other countries where mesquite furnishes the only or principal source of fuel and wood products, because ordinarily, under the common practice of cutting in the spring and summer months, a very large percentage of the wood is converted into piles of boring dust before the end of the summer.

The solar heat principle of preventing insect damage to mesquite posts was found to be entirely successful. The posts were cut and put out in the sun and turned occasionally until the bark was thoroughly dried. This kills the insects that get in before the bark

is dry, and the dry bark is not attacked by insects which are destructive to the wood. This makes it practicable to cut the trees any time during the summer.

*The lead cable borer.*—Studies and experiments at our field station at Los Gatos, Calif., and East Falls Church, Va., relative to damage to lead telephone cables by a wood-boring beetle have been continued with prospects of solving the problem. The telephone companies have furnished a large amount of material and gone to considerable expense to offer facilities for the investigations.

*Chemical treatments of wood.*—Experiments in chemical treatments of commercial wood products to prevent insect damage have been continued, and the results so far indicate that a number of kinds of North American woods can be treated so they may be safely used in tropical countries, where otherwise serious damage would be caused by termites.

*Water submergence and sun-curing treatment of crude products.*—Experiments during the year have shown that a combination of water submergence and sun curing will prevent injury by wood-boring insects to saw logs that must be held over during the spring and summer months.

*Seasonal cutting.*—The extensive experiments in seasonal cutting of timber to determine the best time to do the work have been completed, and the results show that there are optimum times for the cutting of different species of trees to avoid insect damage to the bark and wood. This is of especial importance in connection with material for log houses and rustic work.

*The host selection principle.*—Continued experiments relative to the Hopkins host selection principle tend to establish the fact that insects which attack a number of species of trees or plants prefer to continue their attack on the particular species in which they have bred for a few seasons. This knowledge is of special economic importance in connection with control work against certain insects.

*Shade trees.*—The work on insects affecting shade trees and ornamental hardy shrubs has been limited largely to correspondence, owing to the lack of funds to be devoted to this line of work. There is a constantly increasing demand for information on the subject, and some special investigations have been conducted at field stations at Los Gatos, Calif., and Colorado Springs, Colo. There is urgent need of the extension of this work.

*The bioclimatic law.*—Much time during the year has been devoted by Dr. Hopkins to the continuation of investigations relative to the application of the principles of his bioclimatic law to entomological and agricultural research and economic practice, in which notable progress has been made toward establishing the principles involved and the development of systems of applying them in the solving of problems of utmost importance to human interests.

Recent studies have shown that the law applies to the continental areas of the Northern and Southern Hemispheres, and that it gives a reliable basis for the classification of the major and minor zones of the world in which similar conditions of climate and life may be expected to occur, thus giving a new basis for a more scientific consideration of the problem of the introduction of useful plants and animals and the prevention of the introduction of pests from



one country to regions and sections of another country where the conditions are most favorable for their establishment.

*General results.*—Under the head of general results as related to the pecuniary value to the country of the investigations of insects affecting forest resources, it is significant that wherever control operations have been carried on during the last 15 years in forested areas of the Rocky Mountain, Pacific Slope, and Southern States, principally in the national forests and parks, notable reductions in the dying of the timber followed in each case, and that up to the present time comparatively little timber has died within the areas where only a very small percentage of the original infestation was disposed of.

It has been frequently stated by Dr. Hopkins that it was his belief that if a general and serious and continued effort was made to apply the information that has been disseminated on methods of controlling the principal tree-killing beetles, it would be but a few years until these worst insect enemies of North American forests would be brought under complete control and ultimately they would become rare and require little if any attention. The conditions prevailing at present throughout extensive areas where only a comparatively little control work has been done seem to give good support to the idea.

*The management principle.*—Another striking example of the results of investigations and the dissemination of information is the general decrease in the formerly extensive losses of seasoned hardwood products from damage and destruction by powder-post beetles, not as the result of the application of expensive remedies but of the inexpensive and often better methods of management in the storage, inspection, and use of the material that was advised.

Other changes that have been advised and adopted in the methods of handling and manufacturing of crude forest products and in the general management of public and private forests with little or no additional expense show that the management principle of preventing losses from insects is of fundamental importance.

In connection with the principle of adjusted management to provide against losses from insects and otherwise to secure the best results from energy and money expended, it is found that a knowledge of the laws which govern life and climate will suggest innumerable methods of procedure in combating farm pests, especially in the selection of the optimum time to plant to avoid or lessen insect damage (as in the case of the Hessian fly) and otherwise secure the best results. The adjustments of crops and types of farming to local and regional climatic requirements are among the things which would contribute to the prevention of serious losses and to increased production.

*Estimates of values and losses.*—Estimates based on accumulated data from various sources indicate that the Nation's wealth in forest resources and in shade trees and ornamental shrubbery is not less than \$10,000,000,000 and that the direct and indirect depreciations and losses caused by insects annually to this source of wealth and human welfare represent a money value of 1 per cent. or not less than \$100,000,000.

## WORK ON THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

Work on this project has been continued under the supervision of A. F. Burgess, with headquarters at Melrose Highlands, Mass.

During the spring of 1919 the egg clusters of the gipsy moth hatched almost perfectly, there having been practically no mortality during the previous winter, which was very mild. This fact, combined with the unusual prevalence of high temperatures and favorable air currents during the hatching period, resulted in an unusual spread of the insect in the young caterpillar stage.

Scouting work, which was carried on during the winter, indicated a much larger area infested, particularly in Maine, New Hampshire, and Vermont, than has ever been reported heretofore. A number of additional towns near the northern part of the infested border line in Massachusetts were also found to be infested. Along the balance of the border in southern Massachusetts and Connecticut only a slight increase in the infested area occurred. Winter conditions in New England were particularly severe, there being unusually low temperatures and very deep snow. This interfered materially with the progress of the work of determining the condition of the infestation, and this factor, coupled with the increase in cost of labor and supplies, prevented a large amount of necessary work from being done.

The increase in area found infested during the past year amounts to 4,569 square miles, 1,392 square miles being in Maine, 1,921 square miles in New Hampshire, 524 square miles in Vermont, 371 square miles in Massachusetts, and 61 square miles in Connecticut. These areas were added to the quarantined area in New England, and products shipped from them that are likely to carry infestations must be inspected before they are allowed to proceed. The quarantined area now includes 25,316 square miles.

A reinspection of the old colony sites in New York, Ohio, New Jersey, and the western part of Massachusetts failed to indicate the presence of the insect, and it is very reasonable to believe that these colonies have been exterminated.

The area infested with the brown-tail moth has been materially reduced during the year and 10,677 square miles have been eliminated from the quarantine—8,492 square miles in Maine, 711 square miles in New Hampshire, 714 square miles in Massachusetts, 29 square miles in Rhode Island, and 731 square miles in Connecticut. The quarantined area now amounts to 18,075 square miles.

FIELD-CONTROL WORK.—Scouting of the border area indicated many small gipsy moth infestations in towns outside those under quarantine. In spite of unfavorable weather and scarcity of men, scouting and clean-up work was carried on in 255 towns, distributed as follows: Maine, 89; New Hampshire, 81; Massachusetts, 39; Vermont, 28; Connecticut, 17; and Rhode Island, 1. In addition to this, scouting was carried on in the outside colonies in the other States previously mentioned. During the progress of the scouting work, over 7,800 miles of roads were examined, as well as large areas of orchard, pasture, and ornamental trees and shrubbery.

During the early spring gipsy moth banding material was applied to trees in 29 towns in New Hampshire, Vermont, and Massachu-

setts—11,187 bands being used. Spraying operations were considerably interfered with by an unusual amount of rainfall during the month of June. Two horse-drawn spraying machines were converted into motor-propelled outfits so that there were available for the season's work 14 motor-truck sprayers and 5 horse-drawn machines.

Considerable difficulty was experienced in securing prompt delivery of arsenate of lead, owing to strikes and freight embargoes, but as the season was later than usual, resulting in delayed pupation of the caterpillars, it was possible to carry on spraying work satisfactorily during the first week in July. This, in part, compensated for the difficulties encountered in the early part of the spraying season, although the treatment is most effective if applied as soon as possible after the caterpillars have hatched. The machines were distributed along the border of the infested area in New Hampshire and Massachusetts and one sprayer was assigned to work in Rhode Island. The spraying in Connecticut was done with the equipment of the State entomologist and by the men in his employ. During the season, spraying work was carried on in 22 towns, and 3,617 acres were treated. In addition to this, 14,954 trees growing in orchards and pastures or on private grounds were sprayed.

EXPERIMENTAL WORK.—The extremely severe winter of 1919 resulted in heavy mortality of gipsy-moth egg clusters over a large part of the infested area. Along the seacoast and in the southern part of the area this condition did not exist, except to a moderate degree. Eggs of the gipsy moth that were deposited near the ground, where they were protected by snow, which was unusually heavy during the winter, hatched in a normal manner. Extensive experiments indicate that a temperature of 20° or more below zero is fatal to most of the eggs in the cluster. In case they are protected by snow or other means, this rule does not hold good.

Egg parasitism by *Anastatus bifasciatus* has been very satisfactory in many localities during the past season. The maximum destroyed by this insect, however, is rarely over 50 per cent of the eggs in the clusters, so that the gipsy moth can not be controlled completely by this insect. This parasite spreads very slowly and there are infested areas in the deep woodlands where the species has not yet become established. During the year 1,220,000 specimens were liberated, principally in woodland areas in New Hampshire.

In the fall of 1919 *Schedius kuvanae*, another egg parasite, was found more abundantly than during the previous year. It is particularly susceptible to low temperature during the winter and its numbers were very greatly reduced as a result of the severe winter of 1919. Five hundred and forty thousand were colonized in eastern New Hampshire in the fall of 1919. Colonization of these two species was made possible by assistance rendered by the State entomologist of New Hampshire.

*Compsilura concinnata*, a tachinid fly, occurred in about the same degree of abundance as during the previous year. High parasitism was noted, however, in many of the small isolated colonies, and in one locality under close observation in Melrose the destruction of gipsy-moth caterpillars by this insect was very much higher than usual.



*Blepharipa scutellata*, another tachinid parasite which kills gipsy-moth caterpillars at the time of or just after pupation, was collected more abundantly than last year. Over 65 sample collections from representative localities covering the entire infested area were found to be parasitized to a greater or less extent. In one of these collections the entire lot was destroyed by this insect.

A very striking case of parasitism was found in large collections of gipsy-moth pupæ made in the vicinity of Franklin, N. H. In a single lot of 7,000 pupæ 94 per cent were destroyed by this agency. The insect is now distributed over the greater part of the infested area, and even greater results are anticipated from its presence.

Improvements have been made in the methods of breeding and colonizing *Apanteles melanoscelis*. During the year 22 colonies, containing 11,000 individuals, were liberated. During midsummer the cocoons of this parasite were found in large numbers in locations where it had been previously colonized, and the results from this species during the past year have been very encouraging. Apparently this insect has not yet increased to the point of giving maximum efficiency. *Calosoma sycophanta* is more abundant this year than usual, and many reports have been received from citizens living in the infested area confirming the value of this beetle as an enemy to the gipsy moth. The wilt disease has been reported from more localities than during the previous year.

The area infested by the brown-tail moth has been reduced during the past year, but several bad colonies have been found in the eastern part of Massachusetts and in New Hampshire. A number of cases of severe defoliation to orchard trees resulted and for the first time for several years the moths were taken in small numbers at electric arc lights.

Parasitism of this insect by *Zygobothria nidicola* was about one-half that recorded during the previous year, although there was considerable local variation in the abundance of this parasite.

Parasitism of the brown-tail moth by *Apanteles lacteicolor* and *Meteorus versicolor* was considerably less than in past years. In a single bad colony of the brown-tail moth at Burlington, Mass., the fungus disease *Empusa ulicæ* was present and caused the destruction of large numbers of caterpillars.

A study of the parasitism of native caterpillars has been continued throughout the year and much valuable information secured. During the winter, however, unusually high mortality resulted to the material in hibernation. This work has emphasized the value of *Compilura* as a parasite on many of our common caterpillars.

QUARANTINE WORK.—During the year 33,125 shipments have been inspected and certified and 331 permits have been issued for material to be shipped from the gipsy-moth infested area to points outside. The greater part of the shipments consisted of quarry products, nursery stock, and forest products. Evergreens, such as Christmas trees and miscellaneous material, were also included. More than twice as many Christmas trees and evergreens were shipped than during the previous year.

On July 3, 1920, notification was received that a severe colony of the gipsy moth had been found in Somerville, N. J., and a few days following the insect was reported in Brooklyn, N. Y. Both of these

cases have been investigated. The conditions surrounding the latter indicate that the insect was present in small numbers and vigorous means were immediately taken by the New York department of agriculture and the superintendent of parks of Brooklyn, N. Y., to eradicate it. This work was supplemented by a small amount of scouting work carried on by this bureau. Further scouting should be done during the winter, and if no extension of the colony is found it should be possible to exterminate the insect in this locality within a reasonable time.

The New Jersey colony of the gipsy moth proved to be one of long standing, and the situation is complicated by the fact that large numbers of shipments of trees have been made from and near the colony to many destinations. A record of all shipments has been secured, which shows that stock has gone to 14 different States besides New Jersey. These shipments are being traced as rapidly as possible, and already two infestations in New Jersey, one in Pennsylvania, and one in New York have been located.

Preliminary scouting work by employees of this bureau has shown that the infestation at Somerville occurs in an area of about 100 square miles. The area will probably be increased later, when effective scouting can be done after the leaves are off the trees. The gipsy moth situation, both in New England and elsewhere, is extremely serious at the present time. Sufficient funds are not available to carry on the work effectively, and unless more very thorough work is done the insect is bound to spread rapidly.

The very high cost of supplies and equipment, together with the high price and scarcity of labor, further complicates the successful handling of this problem. Unless adequate funds can be secured to meet this emergency, there is little possibility of preventing the spread of this insect or keeping it within reasonable bounds.

#### SOUTHERN FIELD-CROP INSECT INVESTIGATIONS.

Investigations of southern field-crop insects have been continued under the direction of Dr. W. D. Hunter.

**COTTON INSECTS.**—Owing to rapid development in the studies of boll-weevil poisoning, the work at the Delta laboratory at Tallulah, La., for the fiscal year has been largely limited to different phases of this particular problem. Practical control work conducted in co-operation with cotton planters was extended to include more than 50,000 acres of cotton during the growing season of 1919, and was further expanded in the spring of 1920. Results on the whole have been very satisfactory, and have served as a basis for numerous circulars of advice which have been issued for the benefit of farmers undertaking commercial poisoning work. This method of control has spread very rapidly. During 1918 poisoning was practically confined to the properties under the supervision of the experts from the Delta laboratory. In 1919 the farmers themselves took it up, and during the season approximately 3,000,000 pounds of calcium arsenate were used. The results were so good that in 1920 the demand for this chemical was greatly increased, and, while no accurate figures are available, the total amount of calcium arsenate sold for use this year surely exceeds 10,000,000 pounds.

Effort has been made to reach every man who is poisoning, and to aid him with such advice as seems best suited for his particular case. Consequently it has become necessary to extend the work to include new territory and new conditions. New field stations have been established in southern Louisiana, central Mississippi, southern Alabama, eastern Georgia, and southern South Carolina. In each of these localities observations are conducted to determine the activities of the weevil under the different conditions prevailing as affecting poisoning operations. Close check is also kept on the work of the farmers. The results secured are carefully noted and the conditions influencing these results are studied in an effort to standardize advice. Throughout all of this work, as well as the operations conducted under the direction of the Delta Laboratory, unpoisoned check plats are maintained under varying conditions in order that the exact limitations of profitable weevil control may be determined.

Semitechnical studies, consisting of plat work and cage studies, are being continued with a view of improving methods of poisoning.

The extensive production of calcium arsenate has necessitated the development of a very large project handled in cooperation with the Federal Insecticide and Fungicide Board. Improperly made calcium arsenate may either fail to control the weevil or may kill the cotton plant. Prior to 1919 the manufacture of calcium arsenate was limited, while at the present time over 20 companies are in the market, and this has meant the production of large quantities of inferior material. For their protection, farmers have been advised to buy this chemical on certain specifications and to send samples of the material purchased to the Delta laboratory for analysis before using it. This has resulted in preventing the use of large quantities which would have been very destructive to the cotton, and has involved the analysis of over 2,000 samples of calcium arsenate. These analyses have been made by chemists in the employ of the Insecticide and Fungicide Board. In addition the official inspectors of this board have been assigned to the work and have sampled many of the larger shipments. Portions of each of these samples are tested on plants at the Delta laboratory, and if found dangerous court proceedings have been started and seizures made under the insecticide act of 1910. This work has resulted in saving many crops of cotton and has prevented weevil poisoning from becoming too dangerous and thus falling into disrepute.

Another important phase of the investigations has been the development of suitable dusting machinery. Motor-power dusters proved unsuitable owing to the type of labor available for operation, and a new machine operated by wheel-traction power was developed in cooperation with the Bureau of Public Roads. Blue prints were prepared covering this type of machine and furnished to all interested manufacturers. Several models were placed on the market and more manufacturers are taking them up. The experimental department is now at work developing a cheaper form of wheel-traction machine which will be suitable for the small farmer who has an area too large to cover with hand guns. In addition to this work, manufacturers have been encouraged to forward test machines, many of which have been tried out and advice given for their improvement, all aiming toward providing the cotton farmer with the best and most



effective type of dusting machinery. This question has been so important that a special bulletin (Farmers' Bulletin 1098) has been issued for the use of both farmers and manufacturers.

Much work has been conducted on cotton varieties in relation to weevil injury, weevil hibernation, etc. In addition, the weevil dispersion line for the fall of 1919 was determined.

A Department Bulletin, No. 875, "Cotton Boll Weevil Control by the Use of Poison," prepared during the fiscal year 1920, has been issued since the close of the year.

A study of the field biology of the cotton boll weevil has been completed at the field station of the bureau at Madison, Fla., and the manuscript has been prepared for publication.

During the year a thorough study of the relationship of temperature to the immature stages of the boll weevil was undertaken, with special reference to the application of control measures. During the month of June, 1919, the high soil temperatures at Madison, Fla., caused a mortality of 98 per cent among weevils of the first generation. In other words, there were no more weevils in the field on the 5th of July than were present on the 5th of June, in spite of the fact that time had elapsed for the first generation. These studies indicated that for certain localities in the southeastern Gulf Coast States control experiments could have been inaugurated on the 5th of July with just as good chance of success as had such experiments been performed on the 5th of June.

The field biology of the boll weevil was found to present a considerable variation compared with the biology under insectary conditions. The average time from egg to adult under insectary conditions is approximately 14 days. The studies in the field show that the time from egg to adult, where the weevils are allowed to hatch on the soil beneath the plants, is approximately 22 days. This important discovery has a very direct bearing on the application of methods of control, especially where the time interval between applications of poison is concerned.

A good deal of attention has been given to the possibility of growing sea-island cotton under boll-weevil conditions. Sea-island cotton has been abandoned in almost every section where the weevil has made its appearance. The studies at Madison, Fla., indicate a possibility of making a very profitable crop on certain of the light sandy soils. The studies along this line are being continued and it is expected that some very valuable information will be gained.

**TOBACCO INSECTS.**—The tobacco hornworm continues to be the most important insect pest of tobacco in Kentucky and Tennessee. The shortage of labor and the consequent high wages affect the problem of control. Under former conditions growers did much hand worming during certain periods when labor could thus be advantageously employed, but under present conditions labor is so scarce that the control of the hornworm can be better accomplished by the use of dusting machinery, even when worms are not very abundant. This condition has brought the machinery problem to the front, and has resulted in the devising of a mule-drawn duster which applies the dust poisons to two rows at the same time and much more thoroughly and with much less labor than with the hand duster. This machine will be thoroughly tested and developed during the coming summer.

The labor shortage has also brought the problem of dosages into prominence. The question now to be solved is not to find the minimum dosage that will satisfactorily kill the worms present upon the plants, but to find a dosage that will be effective upon the worms for the longest possible period without injury to the plants. Experiments during the year show that under some conditions twice the usual amount of arsenate of lead was economical when compared with the usual practice of one lighter dosage plus even a moderate amount of hand worming. In one particular experiment the saving of labor amounted to \$5 per acre, and the conditions in this particular field occurred quite generally over the entire so-called Black Patch in Kentucky and Tennessee.

Careful tests of calcium arsenate in comparison with arsenate of lead were made, and the results indicate that the use of calcium arsenate is not to be recommended for tobacco. Even grades containing a very low percentage of water-soluble arsenic oxide injured plants more seriously than did the arsenate of lead.

An important new line of investigation has been started, the result of which can not be determined until the summer of 1922. This work included nearly 1,000 acres of tobacco in Kentucky and Tennessee upon which an effort will be made greatly to reduce the hibernating generation of hornworms by killing them with insecticides upon the suckers, which often grow to great luxuriance after the tobacco crop is housed. The region selected is one in which the growers are the most wide-awake and in which they control the hornworm very well, indeed, during the growing season. If there is anything to be gained by a fall control of the hornworm, the region selected offers the best opportunity for the determination of the value of such control. This suggestion was made by the chief of the bureau for tobacco insects in general more than 20 years ago, but has never been tested on a large scale.

The mosaic-disease work was stopped almost completely during the winter because of the resignation of the investigator who had it in charge. This work has been reassigned to S. E. Crumb, who already has determined one means by which the disease overwinters and has started a comprehensive series of experiments upon the epidemiology of the disease.

The work on tobacco insects at Quincy, Fla., has been divided principally between two primary insect pests—the tobacco thrips and the tobacco flea-beetle. It has been shown that undoubtedly the best time for attacking both of these pests is during their emergence from hibernation, when the plants are small, and sprays and dust mixtures can be more easily and more thoroughly applied.

Through cooperation of one of the manufacturers of spraying machinery, a special power sprayer was secured which is sufficiently narrow to go between two rows of tobacco. However, owing to certain faults in construction and owing to the late date at which this machine was received, it was impossible to use it between the rows this year, but before tobacco was tied up to the top of the sheds the mule machine was mounted upon a farm wagon and five rows of tobacco were sprayed at a time. The results indicate that this method of control is sound, and that undoubtedly this type of machine, when the faults in construction are remedied, will be very valuable to the growers.



The tobacco flea-beetle during 1919 damaged tobacco in some fields at Quincy to the extent of \$600 per acre. A power duster has been secured for the bureau's experiments, and it has been found that a mixture of equal parts of calcium arsenate and tobacco dust, or lead arsenate and tobacco dust, when applied at the rate of 8 to 20 pounds to the acre (usual dosage ranging from 8 to 12 pounds), resulted in a very satisfactory control. However, it was found that late in the season considerable burn resulted from the use of calcium, and the problem during this stage of growth resolves itself into a test of the feasibility of using lead arsenate instead of calcium arsenate in the tobacco dust poison mixture. The objection to the use of lead arsenate is due to its quality of adhering to the leaves, and thus presenting unsightly spots upon the cured wrappers. It is hoped that lead arsenate used in the tobacco dust mixture will wash from the plants sufficiently to overcome this objection.

The use of calcium arsenate in the budworm-control mixture results in severe burning except under the most favorable conditions, and this insecticide must be abandoned for budworm control.

Hornworm control on shade tobacco in Florida is also a serious problem late in the season. Arsenate of lead can not be used straight, because of the "painting" of the leaves and the consequent unsightly appearance of the cured wrapper. Paris green and calcium arsenate are dangerous and injurious except under the most favorable weather conditions. Experiments are under way to ascertain whether a mixture of arsenate of lead and tobacco dust can be used more satisfactorily.

**SUGAR-CANE INSECTS.**—The work for the fiscal year 1920 in Louisiana has been devoted mainly to the introduction of Cuban parasites of the sugar-cane moth borer. In the summer of 1919 E. R. Barber was stationed in Cuba, and sent in about 900 puparia of a tachinid parasite (*Euzenilliopsis diatraeae*), which were successfully established on four Louisiana plantations. It remains to be proved whether the parasites lived through the winter.

The work was continued this summer, but on a much larger scale, funds having been subscribed by a number of progressive sugar planters in support of the work. Mr. Barber went to Cuba in April, accompanied by four student assistants. Several thousand puparia have already been sent in. These are being cared for in a specially designed insectary in which everything is arranged to provide for a maximum of light and air, and owing to special facilities a minimum of time is required in handling the parasites.

Having emerged from the puparia, the flies are allowed to feed and later are taken to the fields in small cages. Positive proof is expected this year as to whether the introduction of Cuban parasites is feasible and whether they can survive the Louisiana winter. If the winter is too cold for them, it may be possible to keep them over in greenhouses, and some sugar planters have suggested reintroducing them every year.

The work of the station at Brownsville, Tex., has been devoted mainly to an intensive study of the biology and control of the sugar-cane borer and its control in the Rio Grande Valley of Texas. Considerable attention has also been paid to the occurrence of the



species upon Johnson grass, Sudan grass, kafir corn, and other plants.

In conjunction with the parasite introduction campaign being conducted in Louisiana, large numbers of larval parasites of the cane borer have been released in the most heavily infested sugar-cane and corn fields. Unfortunately, climatic conditions were such during the winter of 1919-20 that an unusually small number of cane borers survived and the infestation so far this year has been remarkably light. For this reason it is yet too early to determine whether the parasite has been able to establish itself. Under normal conditions the introduction of these parasites promises to be the most simple and effective control measure that can be adopted. A very efficient egg parasite is already present over the greater portion of the infested territory, which at certain seasons destroys about 75 per cent of the total borer eggs deposited.

Experiments during the hibernation period have also proved that under Rio Grande Valley conditions old cornstalks lying in the fields through the winter may be as dangerous, if not more dangerous, than sugar cane under the same conditions, owing to the larger number of wintering larvæ present in cornstalks. For this reason strong recommendations have been made regarding the destruction of cornstalks during the winter. With the high price of cane prevailing, the cane fields generally have been cleaned up very thoroughly, and in two locations at least even the old tops have been used for planting in order to release more cane. This no doubt has been an important factor in the scarcity of borers in the cane fields so far this year.

During the year the cane borer has been discovered in a number of widely separated localities in Texas where it has not previously been known to occur. This includes a number of points along the Gulf coast. For this reason it is important that the general distribution be determined, and a survey has been planned for the near future to cover the infested territory and to discover how far the pest has spread.

#### INSECTS AFFECTING THE HEALTH OF MAN AND DOMESTIC ANIMALS.

**INSECTS AFFECTING DOMESTIC ANIMALS.**—Under the project "Control of the House Fly and Other Insects in Establishments Operating under the Federal Meat Inspection," cooperation was continued with the Bureau of Animal Industry. Progress was made in further perfecting flytraps and baits. Some experimental evidence was obtained as to repellent and attractive chemicals and the possibilities of their use in controlling the house fly and various blow flies. The Bureau of Animal Industry inspectors in charge of the various stations have been proceeding with the work as advised by the Bureau of Entomology, looking toward the permanent abolition of favorable fly-breeding grounds around packing houses and abattoirs.

*Screw worms.*—It has been conservatively estimated that the average annual loss due to this pest is \$4,000,000. There also is a considerable loss due to the wool maggots of sheep. Investigations have been carried out along several lines. A field station has been established in the heart of the sheep and goat raising regions of Texas

near Sonora. It is the purpose to put into actual practice on the range these control principles which have been more or less fully worked out, and observe the results. These practices consist mainly of (1) carcass burning, (2) trapping of flies, (3) poisoning of flies, (4) avoidance of screw-worm attack through various modified range practices, and (5) the development of a satisfactory larvicide and repellent for use on wounds.

During the latter part of the year an active cooperative arrangement was entered into with the Texas experiment station. In the future the field work will be carried on at the Texas substation No. 14, near Sonora, Tex.

The difficulty of securing an effective and convenient bait for use on the ranges has been largely solved by the production of dried gut slime. The fresh slime, a by-product of the meat-packing houses, has been used with much success as a blow-fly bait for several years. The discovery that this product can be greatly concentrated and made available for shipment through drying and at the same time retain most of its attractive principles is an important step forward.

Considerable progress has been made in the development of more efficient repellent mixtures for wounds.

*Horseflies.*—The investigation of the horsefly problem in the Southwest, in cooperation with the Nevada experiment station, was discontinued with the close of the last season. The life history and habits of the principal species were rather fully studied. Many control measures suggested were found to be impracticable under ranch conditions. It was rather conclusively shown that the drainage of the swampy areas and the substitution of more intensive cultivation of the farmed areas, substituting alfalfa, grain, etc., for the native grass meadows, will be necessary to reduce materially the losses from these flies.

*Ox warbles.*—Work on the two destructive species of ox warbles has been continued in various parts of the United States. Further experiments have been carried out which will prove that the larvæ hatch and penetrate through the skin on the heels or elsewhere where the eggs are laid. Moreover, these larvæ, at least in part, go to the gullet of the host before passing to the subcutaneous tissues of the back. A large amount of information on other points in the life history, seasonal history, distribution, and injuriousness of the pests has been obtained. Experiments have also shown that the larvæ can be effectually and economically destroyed by placing certain compounds in the holes in the hide on the backs of cattle.

*Poultry parasites.*—A species of mite (*Liponyssus sylviarum*), not heretofore known as a poultry pest, has been found to occur in injurious numbers in several flocks of chickens in different parts of the United States. An effective control method has been developed, and eradication proved possible through its actual accomplishment in one heavily infested flock.

The depluming mite of fowls has been studied and a simple and effective remedy found.

*Insects and hog cholera.*—During the summer of 1919 an agent was assigned to cooperate with the Bureau of Animal Industry in studying the possible transmission of hog cholera by insects. Earlier work of the Bureau of Animal Industry showed that both the house



fly and the stable fly were capable of carrying the disease for short periods under certain conditions, this suggesting the desirability of securing more data on this subject, and especially to determine if some insect might be responsible for the appearance of cholera at various points sometimes far removed from known cases of the disease. Experiments were carried out with the house fly, stable fly, and *Simulium*. The first two species gave positive transmissions in a number of instances, the results on the whole agreeing closely with those previously obtained by the Bureau of Animal Industry. Studies were also made of the insect fauna of hog excrement and the various ways in which insects are associated with hogs. These should aid in epidemiological studies of the disease.

**INSECTS AFFECTING THE HEALTH OF MAN.**—The work of the bureau laboratory at Mound, La., was materially narrowed during the war period by service in the Army on the part of the force at that station. This condition continued throughout the greater part of the fiscal year 1920. Two definite lines of work were continued having for their objective further definite information on the biology of malaria mosquitoes and the practical antimosquito measures that apply in the prevention of malaria on plantations and farms. These lines consisted of the determination of the relative density or numbers of *Anopheles* in and about plantation houses under varying environmental conditions and the relative capacity of various classes of surface water in *Anopheles* production, together with the effect of such production upon the adult density. During the year the United States Bureau of Fisheries completed cooperative studies on the mosquito-eating fish of the region under observation.

Former lines of work upon the effect of malaria on crop production and agricultural development, upon the relative efficiency of the various species of American *Anopheles* mosquitoes to act as the hosts of the malaria parasites, upon the breeding requirements of *Anopheles* larvæ, upon the density and food requirements of adults for malaria transmission, and upon regional distribution of *Anopheles* in respect to topography, agricultural operations, and agricultural development have not been resumed through shortage of funds.

Malaria, the prevention of which is entirely a biological problem based upon the control of *Anopheles* mosquitoes, costs the United States, and particularly the South, millions of dollars annually in loss on crop returns and in checking agricultural development. The land areas included in the malaria regions are the most fertile lands in the United States. The medical side of the problem is well understood and cared for by the proper treatment. The Government is spending enormous sums of money for protection in small towns and in certain cities through the Public Health Service. The agricultural side is neglected and little understood. The rural side of the problem overshadows all other interests in importance. It is the side upon which definite constructive information is lacking. The investigation is worthy of ample support, the work is within the function of the Bureau of Entomology, and it is advised that in order to hold the present work together and continue the same efficiently further provision must be made for men and for facilities.

*House-fly control.*—A test was begun about two years ago of the durability of various types and grades of screen-wire cloth as used



for protection against flies and mosquitoes. This experiment was undertaken through cooperative arrangement with several State experiment stations, agents of the Bureau of Entomology, and other agencies in about 14 sections of the country, the object being to gain information as to the most economical and effective screen under various climatic conditions. While this test must be continued for several years longer to determine the durability of many of the kinds of wire, some information of value is already obtained. It appears that there is much variation in the durability of certain screenings of the same class and cost, probably due to methods of manufacture. It also appears that in some regions black wire (painted) is even more durable than some kinds of the higher-priced galvanized screens.

*Investigations of insects breeding in human excreta.*—Wilmington, N. C., field station: Owing to lack of funds it was found necessary to discontinue this project. The agent in charge of these investigations was transferred from the bureau on May 31. During the time he was assigned to the project he did very efficient work in rearing the various species of flies which breed in human excreta. Shortly before he resigned from the bureau he had begun experiments with chemicals for the prevention of fly breeding. There was not enough time to reach definite conclusions as to the effect of the chemicals. However, the greatest promise was shown by potassium cyanide solution, sodium arsenate solution, and a pine-tar product acid.

#### TROPICAL AND SUBTROPICAL FRUIT INSECT INVESTIGATIONS.

The work in tropical and subtropical fruit insect investigations is under the charge of the Assistant Chief of the Bureau, C. L. Marlatt.

*INVESTIGATIONS OF INSECTS AFFECTING CITRUS FRUITS IN CALIFORNIA.*—The research work of this station has been largely a continuation of the investigations of liquid hydrocyanic acid for the fumigation of citrus trees. The use of this liquefied gas is largely replacing and probably will ultimately almost entirely replace the old methods of citrus fumigation with gas developed under the tree at the time of fumigation by a combination of the proper chemicals. The special work of this year has been a study of the diffusion of liquefied hydrocyanic acid under various temperatures and the effect of the gas on citrus insects as the temperature is reduced. Attention has been given the subject of daylight fumigation, and it is evident from the results thus far obtained that fumigation of dormant citrus trees during the day is possible providing the proper dosage and exposure are employed.

The Argentine ant investigations referred to in the report for the fiscal year ended June 30, 1919, have been continued, owing to the fact that some of the ant poisons recommended crystallized during cold weather and soured in the presence of a humid atmosphere, and as a result it has been necessary to modify some of the formulæ to meet winter conditions. Considerable time has also been devoted to instituting ant-control campaigns in citrus centers where the Argentine ant is abundant. A number of papers dealing

with insect problems in California have been published during the year.

**CITRUS FRUIT INSECTS IN FLORIDA.**—The work under this project has been a continuation of that described in the previous report. The value of the dust method for controlling rust mites has been determined and many demonstrations have been conducted throughout the State. Cooperative work with the Bureau of Plant Industry has been carried on for the purpose of developing a combination spray which will be effective against insects as well as plant diseases. As in the past, considerable attention has been given to the control of the citrus white fly and the scale insects which commonly infest citrus plants in Florida.

**INVESTIGATIONS OF INSECTS AFFECTING MANGO, GUAVA, AVOCADO, AND OTHER SUBTROPICAL FRUITS.**—During the year the insects infesting the plants listed above have been studied at the Miami station. A paper has been published on the banana root-borer, and several papers are in course of preparation describing the life history and methods of controlling the principal injurious insects infesting the avocado, mango, and papaya. The work of this laboratory has been in close cooperation with the Federal Horticultural Board in an effort to safeguard against the introduction of insects injurious to tropical and subtropical plants.

**STUDIES OF GREENHOUSE INSECTS.**—The work under this project has been for the most part limited to the study of the strawberry root-worm, an insect which in recent years has developed into a serious pest to roses grown under glass. This insect is now established in widely separated localities and is reported to have been responsible for the loss of some \$70,000 in one county alone in the State of Pennsylvania during the present year. In order to study this insect under field conditions a temporary station has been located in Pennsylvania, and active work is being conducted in collaboration with the Pennsylvania State Department of Agriculture.

An investigation of the chrysanthemum midge has been completed, and a bulletin (Department Bulletin 833) has been published, giving general information on the life history, habits, and methods of controlling this chrysanthemum pest.

**MEDITERRANEAN FRUIT FLY AND MELON FLY.**—As heretofore, the work at the laboratory at Honolulu has consisted primarily in the inspection and certification of pineapples, bananas, coconuts, and taro for shipment from Hawaii to the mainland. Further studies have been made to determine the effectiveness of parasites and other natural enemies in controlling the Mediterranean and melon fruit flies. In addition to the fruit-fly problems, a study of the principal insect enemies of the algaroba bean—an important stock food—has been undertaken in collaboration with the Office of Stored Product Insect Investigations.

**GEOGRAPHICAL DISTRIBUTION OF FRUIT FLIES.**—A survey was made in Spanish Honduras to determine the injurious fruit flies and tropical and subtropical fruit insects which are present in that country and which may enter the United States in shipments of fruit to southern ports. A number of injurious tropical and subtropical insects were found and a report of this trip is in the course of preparation.

**INVESTIGATION OF FRUIT FLIES AND OTHER TROPICAL AND SUBTROPICAL FRUIT INSECTS IN THE CANAL ZONE, PANAMA.**—The work of this project has been somewhat curtailed during the year owing to the loss of the services of the assistant in field charge. The work has, however, been conducted in a modest way and additional facts have been secured concerning the life history, habits, and distribution of the so-called black fly of citrus, which has been established in the Canal Zone for several years. The survey of injurious insects established in the Canal Zone has been conducted primarily for the purpose of determining the injurious insects which may be brought to southern ports in cargoes of fruit.

**INVESTIGATION OF CAMPHOR THRIPS.**—A study of the camphor thrips was undertaken for the first time this year and a temporary field station was established at Satsuma, Fla. The work in this laboratory included the life history and methods of controlling this thrips in nursery stock and camphor plantations. Although this work has been under way for a comparatively brief period, substantial progress has been made.

#### BEE-CULTURE INVESTIGATIONS.

The work of the Office of Bee Culture Investigations, under Dr. E. F. Phillips, as formerly, has been largely a continuation of the work instituted during the war for the increase in honey production, while at the same time an effort is being made to take up again some of the investigational work which was dropped during the rush of war activities. The educational work begun during the war has proved so beneficial and so popular that it is not desirable or even possible to discontinue it. The laboratory and apiary are still located at Somerset, Md., near Washington.

**DEMONSTRATIONS IN BEE CULTURE.**—The funds available for this work were reduced this year by the loss of the funds available under the food-production act, and because of this decrease it was necessary to drop the work in some States. In deciding which States should no longer receive aid from this office an effort was made to discontinue this aid in those States where the project would be continued on much the same scale by the States alone, and in most cases this was done. At present in every case where this office contributed to the work it is supported by both the States and this department, and, as it is now expected that the demonstration work will be a permanent feature, plans have been made for the entire administration of the movements of the extension men by the several cooperating extension divisions. In all, seven States are now cooperating with the office in this work. While during the war it was possible to obtain the services of men willing to make a considerable financial sacrifice, it is now virtually impossible to get competent men who will take up this work for the salaries offered because of the greater income possible from honey production by those fitted for the extension activities in beekeeping. It is therefore not feasible to increase the extension work in beekeeping rapidly with the present salary scale.

The work of the demonstration men has been along the lines mentioned in previous reports, the only change being that gradually



they are devoting more of their time to those who aim to make beekeeping their life work and who, therefore, are willing and able to carry out the plans of honey production advocated by the department. The specialization in beekeeping, which has been noticeably increasing during the last few years, has received a great impetus from the growth of beekeeping during the war, and it is now clear that the future of beekeeping rests in making better beekeepers of those extensively engaged in the work rather than to induce more people to take up the work.

Mention was made in the last report of a new type of extension work that was being tried, namely, the holding of schools for commercial beekeepers, each of a week's duration. It is obviously impossible in short meetings to present the subject of beekeeping in a comprehensive manner, and in order that the teachings of the office might be presented better these schools have been continued and have been received with enthusiasm wherever presented. Since these are conducted by men from the office and not by the regular extension men, the number which can be presented is limited. During the year 11 such courses were given and 2 others were discontinued at the last minute because of the influenza epidemic. The average attendance at these schools was well over 100, which is about as large a number as can be handled efficiently. While these schools are planned for commercial honey producers, it is found that those not yet heavily engaged in beekeeping but who desire to take up the work are able to attend these schools with profit, and at each school there have been several such persons in attendance.

The bulletin on swarm control, mentioned in the last report, has been completed but not yet published. Two manuscripts of a practical nature have also been prepared during the year, one on beekeeping methods applicable in the buckwheat region and the other in the region where tulip tree is the major source of honey. It is believed that many beekeepers fail to take full advantage of the department's publications in which the principles of beekeeping are presented, because of the difficulty of making the necessary local application, and it has therefore seemed wise to prepare detailed and specific directions which will apply to certain designated regions, and to no others, in order that they may be more readily followed. It is hoped to prepare other bulletins of this character as soon as data are available, one other having already been partially prepared.

**WINTERING OF BEES.**—The object of the work on wintering is, of course, to provide methods whereby the beekeeper may not only save his bees from death during the winter, but whereby the colonies may be able to build up rapidly in the spring to reach maximum strength in time for the honey flow. In order to have a better understanding of the latter phase of the problem, measurements were begun with the first brood of the season of 1920, and at weekly intervals the exact amount of brood in each of several colonies was determined. This gives not only the total amount of brood reared by each colony before the honey flow, but also shows changes which occur in the rate of development. This work was continued up to and then through the honey flow. The making of the observations in an exact manner takes so much time that it has not yet been possible to analyze the data, but from what are now at hand it is clear that this work offers

information which will prove valuable to the beekeeper. This phase of the problem is being undertaken by Lloyd R. Watson, and he will as rapidly as possible get the data into shape for presentation. In all probability it will be necessary to repeat the work on other colonies another year before presenting it in bulletin form.

The loss of bees during the winter of 1919-20 was excessive, owing partly to the fact that beekeepers did not give the attention to this work which it demands, but largely to the fact that in some regions there was a shortage of nectar in the fall; and, as sugar was not available for the feeding of bees, many beekeepers were compelled to put their bees into winter quarters with insufficient stores or with honey of poor quality. The losses of the winter, which was a most severe one for bees, will scarcely be made up by the increase made by beekeepers during the present summer. Because of this great loss, every effort is being made to spread the information regarding the methods to be used to prevent a recurrence of the loss another winter, but it is realized that it will take many years to get even the commercial beekeepers of the country fully to realize what can be done by the use of better methods. The wintering problem in beekeeping has now become largely a problem in education.

**DISEASES OF BEES.**—This project has been continued without interruption. During the year a Farmers' Bulletin (No. 1084) was issued giving the best-known methods for the treatment and control of American foulbrood. Two papers, one on American foulbrood (Department Bulletin 809) and one on European foulbrood (Department Bulletin 810), were issued during the year giving the results of investigations on these diseases, which were completed several years ago but which were delayed in presentation. A most important contribution of the year on the subject of bee diseases was a paper detailing the activities of bees in cleaning out European foulbrood (Department Bulletin 804), it now being clear that the control of this disease lies in getting the bees into such condition that they are able of themselves to clear out every trace of the infection. During the year 700 samples of brood were examined for beekeepers and apiary inspectors.

Considerable work has been done on the factors influencing the distribution of European foulbrood. It has been found that this disease can not continue in regions where there is an early heavy honey flow, and from the records of the office for the last 14 years it is possible to indicate quite clearly those regions where there is reason to take preventive measures against the disease. Combined with this work must go a study of the beekeeping resources of the various parts of each State. This work is being continued, and it is hoped that in the near future a bulletin may be prepared showing the present distribution of the disease according to the records, and also pointing out in each region the factors which reduce or increase the danger from this serious disease. This work will show where it is most necessary to apply the methods already discussed in previous publications of the department.

**BEEKEEPING AFTER THE WAR.**—In previous reports mention has been made of the effects of the war on beekeeping, and it may be well to point out the trend of the industry since the armistice. The stimulus to beekeeping which resulted from the war has become even more

marked since the cessation of hostilities, and beekeeping is still increasing in extent and importance at a rapid rate. The dealers in beekeeping supplies, the breeders of queen bees, and those who deal in full colonies of bees have during the present season faced the largest demand for their goods in the history of the business as a commercial enterprise. The subscriptions to the journals devoted to beekeeping are rapidly increasing and the demand for beekeeping literature, both that from the department and that published privately, is the largest in history. A factor which contributed largely to this continued increase in the importance of beekeeping was the fact that sugar was scarce, but this does not by any means fully explain the great present demand for honey or the fact that so many beekeepers are engaging still further in the industry. Honey is now being used in the manufacture of ice cream and in confectionery, but the greatest demand is, of course, for home consumption, and this demand is greater at present than ever before. The demand for honey for export, which was so important a factor during the war, has virtually ceased, because of the rates of foreign exchange, but in spite of the fact that American beekeepers looked for a continuation of this demand as an important factor in the future of the industry, the loss has been fully made up by the increased demand for honey at home.

There has been a tendency for the last 20 years toward the development of beekeeping as a specialty, and this has been considered as a desirable condition, rather than that bees should be kept on every farm. The heavy winter losses of 1917-18 and again in 1919-20 resulted in the loss of most of the colonies in the hands of careless beekeepers. Furthermore the beekeepers who kept only a few colonies failed to realize the demand for more honey, while those engaged in the work as a major occupation were able and anxious to take full advantage of the opportunities presented. This combination of circumstances has greatly hastened the placing of beekeeping on the basis of a specialty in agriculture, and to-day the industry is further ahead by 20 years than it would have been without the stimulus of the war and the severe losses of winter.



## REPORT OF CHIEF OF BUREAU OF BIOLOGICAL SURVEY.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF BIOLOGICAL SURVEY,  
*Washington, D. C., September 4, 1920.*

SIR: I have the honor to transmit herewith a report of the work of the Bureau of Biological Survey for the fiscal year ended June 30, 1920.

Respectfully,

E. W. NELSON,  
*Chief of Bureau.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### WORK OF THE BUREAU OF BIOLOGICAL SURVEY.

The activities of the Bureau of Biological Survey are conducted under four divisions: (1) Investigations of the food habits of North American birds and mammals in relation to agriculture, in charge of Dr. A. K. Fisher; (2) biological investigations, with special reference to the habits and geographic distribution of native animals and plants, in charge of E. A. Goldman; (3) supervision of national mammal and bird reservations, in charge of Dr. G. W. Field until December 6, 1919; in charge of H. F. Stone since July 1, 1920; (4) administration of the migratory-bird treaty act and enforcement of the Lacey Act regulating the importation of birds and wild mammals and the interstate shipment of game, in charge of George A. Lawyer.

From the time of the organization of the Biological Survey its main purpose has been to study the habits and distribution of our wild birds and mammals, to assist in the conservation of the beneficial and harmless species, and to devise practical methods for the control of those classed as injurious. The files of the bureau contain an unparalleled volume of information drawn from 35 years of field work of its experts in all parts of North America and from thousands of collaborators as well as from published sources.

During recent years appreciation of the value of our wild life has grown rapidly, and constantly increasing demands are voiced for the conservation of the useful and harmless forms. In this same time changing conditions due to increased occupation of the country have caused certain species both of birds and of mammals to become so seriously injurious to crops, forestry, and stock growing that it has become necessary to develop effective methods for controlling or destroying them on a large scale.

As a result, the demands from many directions for increased activities on the part of the bureau far exceed the possibilities of meeting them with the funds available. As in other branches of the Government, the bureau suffers from the loss of skilled employees due to larger salaries paid outside the service and from the necessity of paying higher prices for services and material.

### ECONOMIC INVESTIGATIONS.

With the rising values of all food products and the urgency of increased production, the suppression of crop and stock destroying pests becomes increasingly important. At the time this work was launched on a large scale in 1917 it was estimated that injurious native rodents, as ground squirrels, prairie dogs, pocket gophers, jack rabbits, and field mice, each year destroyed crops and forage in the United States valued at approximately \$300,000,000; house rats annually destroyed about \$200,000,000 worth of food products and other property; while predatory animals were killing live stock having a value between \$20,000,000 and \$30,000,000. Recent investigations of some of the smaller rodents, as kangaroo rats, show that the myriads of these animals also, which are largely seed and root eaters, have a far greater destructive effect on both cultivated crops and native forage grasses than has been realized.

The Biological Survey has demonstrated the possibility of eliminating the larger part of these losses. The destruction of mammal pests has been so successful that farmers and stock growers of the West, where such losses are greatest, are increasing their demands upon the bureau for more extended work to a degree which becomes embarrassing, in view of the limited Federal funds available. The fact that the unoccupied lands of the public domain are the main harboring and breeding places of these pests makes the need for added funds more pressing, since private landowners undertake to destroy the pests on their holdings and ask that the Government destroy them on public lands adjoining.

The reduction of available funds by the discontinuance of the war emergency fund on June 30, 1919, together with a steady increase in the wages of men and in the cost of materials, has handicapped the bureau in its work. The amount of money being appropriated for cooperative undertakings by States, counties, associations, and individuals has rapidly increased until during the present year it has reached the sum of \$1,114,000. This tangible evidence of appreciation of the practical value of the work is due to actual demonstration of increased forage and stock production on the ranges and of additional crop yields on farms through the elimination of mammal pests at a reasonable cost. A conservative estimate of the saving effected during the year from the campaign against rodents amounts to about \$10,000,000, and from operations against predatory animals to about \$6,000,000.

The predatory animal and rodent-pest suppression work is definitely organized in 14 districts covering 18 States, the districts being in charge of inspectors with trained assistants cooperating with the States Relations Service, State and county officials, and community

organizations, as farm bureaus and stockmen's associations. The districts are as follows:

- |                            |                        |
|----------------------------|------------------------|
| 1. Washington.             | 8. Utah.               |
| 2. Oregon.                 | 9. Nevada.             |
| 3. Idaho.                  | 10. California.        |
| 4. Montana.                | 11. Arizona.           |
| 5. North and South Dakota. | 12. New Mexico.        |
| 6. Wyoming-Nebraska.       | 13. Oklahoma-Arkansas. |
| 7. Colorado-Kansas.        | 14. Texas.             |

As soon as funds are available it is planned to assist in the organization of cooperative campaigns against mammal pests in Iowa and Minnesota. Assistance in eliminating losses from rodents is being requested in many other States from the Mississippi Valley to the Atlantic coast.

#### PREDATORY ANIMALS.

A force of skilled hunters and trappers, varying from 300 to 400 in number, were employed under bureau supervision during the year to destroy predatory animals. A part of these men were paid by the Federal Government and a part by cooperating States, counties, livestock associations, and individuals. For this purpose \$272,000 was expended by cooperators in Arizona, Colorado, Montana, North Dakota, Nevada, California, New Mexico, Oregon, Washington, Texas, Utah, and Wyoming. As heretofore, the skins taken by each hunter become the property of the organization or individual paying his salary. The numbers and kinds of skins taken by these hunters during the year were as follows:

Wolves.....	523
Coyotes.....	21, 558
Mountain lions.....	189
Bobcats.....	2, 987
Canada lynxes.....	10
Bears.....	94
Total.....	25, 361

The skins taken by Federal hunters during the year sold for \$42,048.80, making a total to date of \$240,791.65 turned into the United States Treasury in connection with this work.

In addition, extended poisoning operations were conducted over great areas, especially in Wyoming, Utah, Nevada, Arizona, and New Mexico. Judging from the dead bodies found, the number of coyotes killed in this way was approximately the same as the total of all animals trapped. It has become evident that systematic poisoning operations on a large scale, employing modern methods under careful supervision, are a most economical and practical means of reducing the number of coyotes. Extended experiments have been conducted both at the Albuquerque, N. Mex., laboratory and on the ranges and forests. Good progress has been made in developing more effective poisons as well as improved methods of establishing stations and distributing poison for coyotes. These have been successfully applied in organized cooperative campaigns.

In many large grazing ranges, mainly through poisoning followed by systematic trapping, coyotes have been so thoroughly eliminated that sheep owners, with practically no losses, now permit their sheep to graze freely without close herding. Important lambing grounds



have been similarly protected so that ewes and lambs are allowed to range freely without being driven to bedding grounds at night. This has made it possible to carry at least one-third more ewes on a lambing ground, to save a higher percentage of lambs dropped, and at the same time to reduce the expense of handling. The practical elimination of coyotes from the range country will result also in a great increase in both the wool and the meat output. In addition to the sheep they kill, coyotes destroy many goats, calves, pigs, and domestic fowls, and are among the most destructive enemies of large and small game, including both birds and mammals. The bobcat ranks next to the coyote in destructiveness to sheep and goats, while wolves, mountain lions, and some bears cause heavy losses of cattle and horses.

Not all predatory animals are equally destructive of live stock. Some individuals become strongly marked among their fellows because of their depredations. This is particularly the case with mountain lions, wolves, and coyotes. As illustrative of losses caused by these animals, the following instances, which have occurred during the year, may be cited:

One mountain lion killed by a bureau hunter near Roosevelt, Ariz., had a record of destroying 50 calves and 3 colts on one ranch besides many killings on other ranches.

A trapper in New Mexico found 23 calves killed by a notorious wolf which he succeeded in taking; another wolf had killed 30 head of cattle in Wyoming before being captured; a pair of wolves killed near Split Rock, Wyo., were each reported to have killed from \$1,500 to \$2,000 worth of stock a year; another pair of wolves which were taken were known to have killed 100 sheep and 7 colts for one rancher and 50 sheep for another during the month before they were captured.

Coyotes in New Mexico were reported taking from 3 to 6 lambs each night from one ranch, notwithstanding the fact that Mexican herders were sleeping in close proximity and that the usual devices were employed to keep the animals away. After a bureau hunter had killed 7 large, old coyotes and 2 wildcats in the vicinity the losses entirely ceased.

In Custer County, S. Dak., during a period of six or seven years, one wolf still at large is credited with having killed more than \$25,000 worth of cattle. Other notorious individual stock-killing animals occur in all parts of the range country.

Whenever a report of the activities of such predatory animals is made to a district inspector of the bureau, expert hunters are detailed to effect their capture. In this way the careers of many of the most notorious stock killers of the western ranges have been ended.

#### RABIES.

Predatory animals are carriers of rabies, which still persists in California, Nevada, Utah, Idaho, Oregon, and Washington. The destruction of these animals through the campaign led by this bureau has greatly reduced the occurrence of the disease and the losses caused by it. Now, whenever an outbreak of rabies is reported, trappers are concentrated about the locality, the affected animals are soon destroyed, and the disease promptly disappears. But for the

continuance of this preventive work rabies would quickly become as disastrous an epizootic as when its control was first undertaken.

#### CONTROL OF RODENT PESTS.

The work of rodent eradication has made a steady, consistent growth both in territory covered and in thoroughness of organization. In this the bureau has continued to cooperate through the States Relations Service with the State extension organizations, including county agents and farm bureaus. Wherever other State or local organizations were available, as State departments of agriculture and agricultural commissions, they also have been enlisted in the movement. The Forest Service has cooperated heartily in units of operation involving national forests, while the Office of Indian Affairs of the Department of the Interior has joined similarly in work on Indian reservations.

This cooperation, which has united all Federal, State, and local agencies in a carefully planned, concerted drive against rodent pests, has greatly increased the extent and effectiveness of the work. Under the leadership of bureau specialists detailed to organize and conduct **these campaigns**, rodent eradication has become one of the major projects of farm bureaus and of county agents in the territory now districted. The definiteness and value of the results accomplished and the promptness with which these returns on the effort and investment are secured have made this work one of outstanding importance in the movement to increase crop, forage, and live-stock production. Detailed plans for the organization and conduct of these cooperative campaigns are prepared in consultation between the district representatives of the Biological Survey, the State extension director, and the county agents. The bureau assumes the cost of operations on Federal lands, the State officials on State lands, and the farmers and stockmen pay the cost of work on private lands either directly or through taxes levied by the counties. Concerted campaigns systematically organized to destroy rodent pests over large areas of Federal, State, and private lands are proving an entirely practical way of coping with rodent pests, and have made it possible for the first time in the history of the country to make effective headway against them on a large scale.

In addition to the advantage derived by individual landowners from these concerted attacks under the guidance of bureau experts, farmers and stockmen have been saved many thousands of dollars a year by a plan of cooperative purchase of strychnine and other materials used in the poison operations. This was devised and put into effect by the bureau, and by it the enormous quantity of over 4 tons of strychnine has been arranged for and supplied at a very material saving in cost. In Idaho officials report that not only has this saving in that State alone amounted to \$21,000 during the year, but also they have been enabled to secure the large quantities required promptly at the time needed for the most effective prosecution of the campaign. This latter feature has been most important in the development, without serious interruption or delay, of the extensive rodent eradication campaigns during the last three years.

The areas seriously infested by rodent pests in the States west of the Mississippi River comprise more than 200,000,000 acres. Field



operations during the last four years have shown that the worst of these pests, as prairie dogs, certain species of ground squirrels, and pocket gophers, can be eradicated from a great part of the farming and best forage-producing regions of the West at a cost which is merely nominal as compared with the annual increase in the production of the land. The large and constantly growing expenditure of funds and application of labor by cooperating farming and stock-raising communities are conclusive evidence of the practical character of these campaigns. Under the modern methods of the bureau, the first time the rodents are poisoned over a large area from 85 to 98 per cent of the animals are killed. This accomplished, follow-up measures to complete the work are organized as needed during the same and subsequent seasons.

#### PRAIRIE DOGS AND GROUND SQUIRRELS.

Prairie dogs and ground squirrels are the most widespread and conspicuously destructive rodents affecting cultivated crops and range grasses in the States west of the Mississippi River. They do their damage by digging out the planted seeds and cutting down the growing grain until harvested, by eating off alfalfa, clover, bean, pea, and similar legume and hay crops, and by feeding on forage grasses and digging out their roots, thus destroying the stand. Lands thus denuded of native grasses are often subject to serious erosion, resulting in permanent damage to the soil. Prairie dogs occur from Texas north to North Dakota and Montana and from Kansas west to Utah and Arizona. Ground squirrels of several species live in vast numbers over all of the States west of the Mississippi River, involving all of the area occupied by prairie dogs, but becoming most conspicuously destructive in the Northern and Western States, including the Dakotas, Montana, Wyoming, Idaho, northern Utah and Nevada, Washington, Oregon, and California.

The plans of organization, the seasonal work, and the methods of extermination for eradication campaigns against both these groups of rodent pests are essentially the same. The details differ somewhat, however, both with respect to the species concerned, the seasonal, weather, and crop conditions, and the topography of the country. The local representatives of the Biological Survey carefully observe and study these features and apply the measures which have proved most effective and economical.

Particularly notable results are now being secured on a large scale in the campaigns against prairie dogs in New Mexico and Arizona. An illustration of this work is furnished in one especially valuable range area in Sulphur Springs Valley, Cochise County, Ariz., a tract 12 miles long and 4 miles broad, involving 30,700 acres, which was completely cleared of prairie dogs last spring. Adjoining range occupants then appealed to the inspector in charge to assist them in conducting the work over their areas, with the result that by June 30 three-fourths of the area in both Cochise and Graham Counties was completely cleared of prairie dogs. Work to clear the remaining portions of these counties is progressing rapidly. The progress made in eradicating a very heavy infestation of prairie dogs from the valuable range areas of Moreno Valley, northern New Mexico, is another good example of the advance which is being made in the or-



ganized campaigns against these pests. In Kansas, after years of effort, extermination of prairie dogs was accomplished except for a few scattering small towns; through neglect of landowners to complete the work, reinvasion of adjoining cleared areas is beginning to occur. Effort is now being concentrated upon these small areas of infestation, involving 25 to 40 acre tracts, which are widely scattered throughout the middle and western counties.

Similar illustrations may be cited of effective work in the enormous campaigns now being waged against ground squirrels. In Camas Prairie, a fertile valley inclosed by mountains in Camas County, Idaho, where a heavy infestation of Columbia ground squirrels was on the point of driving out the settlers, relief was afforded through the organization of a campaign against the pests, with the result that at present scarcely a ground squirrel can be found in this area, involving 59,000 acres. In North Dakota the Richardson ground squirrel, commonly known as "gopher," formerly caused an annual crop loss estimated by State officials at \$6,000,000 to \$9,000,000, depending upon seasonal conditions. The eradication campaigns have now progressed to a point where in many counties these ground squirrels are no longer looked upon as a menace by the landowners, but merely as occasional objects of interest and curiosity. There is a strong tendency under these circumstances for landowners to discontinue the concerted campaign to complete their eradication. Every effort, however, is being made to have this work continued in such counties in order to prevent any possibility of the animals increasing to a point where they may again become destructive of crops. Indolence and neglect can be the only possible reason for such a condition arising, as under the leadership of the bureau and county agents the farmers have become thoroughly familiar with and experienced in effective measures for destroying these animals.

In the campaigns against prairie dogs and ground squirrels during the year, 19,117,737 acres of Federal, State, and private lands were given a first poison treatment, and follow-up work was done on 15,172,709 acres. Through State and county appropriations and funds expended by individual landowners, cooperative funds were contributed amounting to \$841,909. The quantity of poisoned grain distributed amounted to 1,610 tons, while the number of farmers and stockmen actively cooperating numbered 121,435. The work resulted in a saving of crops for the year estimated at \$10,000,000.

#### POCKET GOPHERS.

Extensive work has been done during the year in demonstrating methods of destroying pocket gophers and organizing community campaigns against them in Kansas, Nebraska, Idaho, Oregon, New Mexico, and Arizona. Many farmers report killing as high as 95 per cent of the pests with one application of poison. The animals occur in every State west of the Mississippi River, and are especially injurious to alfalfa and grazing lands, hay meadows, orchards, and root crops. They often ruin the stand of alfalfa by cutting off the tap roots, and in Kansas, State officials estimate the annual loss to the alfalfa growers alone from this source at \$5,000,000. Pocket gophers greatly reduce the quantity of hay that can be harvested,

both by injuring the stand and by piling up mounds of dirt over considerable portions of the crop; these mounds interfere with cutting the hay and frequently damage the harvesting machinery.

In Kansas and Nebraska, where the pocket gopher is the most serious rodent pest affecting the producers, the efforts of the bureau representatives are concentrated particularly upon the organization of effective community campaigns for its eradication from farming districts. Excellent progress has been made and a foundation laid for more extensive operations during the coming year. In Arizona pocket gophers caused very serious losses in orange and grapefruit orchards by gnawing the roots of trees and thus killing them.

The burrows of pocket gophers in the banks of irrigation ditches have resulted in great damage in parts of Arizona, Idaho, and other irrigation States by causing breaks, which were followed by serious loss of water at critical periods, by the inundation and destruction of crops, and by large expenditures for repair of the ditch banks. Extensive poisoning operations were organized with a view to destroying the pests in such situations and preventing damage of this character. In Arizona chambers of commerce, associations of orange and grapefruit growers, water users' associations, and others joined actively with bureau representatives in conducting these campaigns. The Office of Indian Affairs cooperated by poisoning these animals on considerable areas of the Moqui and Parker Indian Reservations in Arizona. The Forest Service also has given active cooperation in Nebraska, Oregon, and other States.

The same general lines of procedure are followed in initiating and organizing campaigns for the destruction of pocket gophers as in the case of other rodents, and, with a like cordial response by the people interested, important results were attained in protecting crops and property from damage by these animals.

#### JACK RABBITS AND COTTONTAILS.

Jack rabbits are seriously destructive in many of the Western States. They frequently concentrate in enormous numbers in grain fields, orchards, vineyards, and other cultivated areas by moving in from surrounding sagebrush or range. In such instances they completely devastate large fields of growing grain, eat off the crowns of the young alfalfa, and entirely destroy valuable orchards and vineyards that have been built up only after large expenditures and years of unremitting toil. Pathetic instances have occurred where orchards representing the work and savings of a lifetime and constituting the sole reliance of the owners for future support, have been brought to a bearing age only to be destroyed in a single night by jack rabbits. During the winter these animals also congregate about stacks of hay and grain provided for winter stock feed, and frequently eat around and undermine them to such an extent that the stacks topple over and become practically a complete loss. The rabbits also make heavy inroads on the crop of long staple cotton, an important and rapidly developing feature of production under irrigation in Arizona. Last year one producer near Chandler, Ariz., lost from this source his entire cotton crop valued at \$2,500. This year a campaign was organized in this vicinity to destroy the rabbits, and in it many thousands

of them were killed; as a result, no damage has since resulted to the cotton crops in this locality.

Campaigns for the destruction of jack rabbits were organized on a large scale in Idaho, Oregon, Washington, Nevada, Utah, and Arizona under the leadership of bureau representatives and along co-operative lines similar to those employed in combating other rodents. In some instances the destruction of these animals was accomplished through extended poisoning operations. In Lincoln County, Idaho, farmers reported an average of 400 rabbits killed with each ounce of strychnine used, while two farmers in Gooding County reported killing 1,000 rabbits with each ounce. Minidoka County reported killing 40,000 rabbits in their poisoning campaign. Great numbers of jack rabbits were also destroyed by organized drives in these States. In some instances the animals were shot as the drive progressed toward a point of concentration made by converging fences or natural barriers. In others they were driven into fenced inclosures and killed. The destruction of as many as 10,000 jack rabbits resulted from individual drives of this character. Farmers report practically complete protection of their crops the present season in localities where these campaigns were conducted.

Many thousands of skins of the rabbits thus killed were cured and marketed at good prices. Wherever it was practicable to do so the carcasses of unpoisoned rabbits were also prepared and shipped to city markets for human consumption; in other cases they were utilized as feed for chickens and hogs. In some localities it was possible to keep jack rabbits under control merely by bringing the market value of the skins and carcasses to the attention of the people.

Complaints of damage by cottontail rabbits were received from many localities throughout the country. As an example of the destructiveness of cottontails may be cited a new 3-acre vineyard planted during April, 1920, in a foothill location in Tulare County, Calif. Before the end of May the vines had been completely destroyed, the rabbits even digging down to get at the tender sprouts. This delay of a year in establishing the vineyard, together with the money expended on it, involves the loss of hundreds of dollars and is an illustration of the kind of damage done in numberless places on a great variety of garden truck and orchard crops. Advice covering methods of control by means of properly built woven-wire fences and the employment of poisons and traps has been given numerous inquirers desiring to eliminate losses from this source.

#### MICE, WOOD RATS, AND COTTON RATS.

Damage by various kinds of meadow and pine mice in orchards has been very widespread, extending from the orcharding sections of Virginia, Maryland, Pennsylvania, and New York west to Washington, Oregon, and Idaho. In the last three States assistance was rendered the orchardists through the bureau's regular force of experts engaged in local rodent-eradication work, and effective measures of destroying these pests were demonstrated. In the Eastern States orchardists, florists, and truck farmers were aided through circulars and bulletins describing methods of eradication. In a few instances it was possible to detail representatives from the Washington office to near-by points to demonstrate effective procedure.



Wood rats have continued to do damage in some localities, especially in forest and nursery plantations throughout the West. As cases of this kind were reported they were dealt with by representatives of the bureau in the territory affected by means of written instructions or demonstrations.

Cotton rats and rice rats have been responsible for considerable damage in Florida to the sugar-cane crop. Effective methods of poisoning these animals were determined and the planters advised regarding practical procedure.

#### BEAVERS AND WOODCHUCKS.

In some localities, especially in the State of Washington, beavers caused considerable damage to orchards and farm crops as well as to timber in areas along streams where they construct their dams and houses. Investigation disclosed that in many cases the damage was sufficiently serious to warrant removal of the animals. Arrangements were made with State game officials for the necessary captures and for the removal of the beavers to other places where they could be permitted to multiply without endangering valuable timber supplies or cultivated crops.

Mountain beavers, or sewellels, also have continued to do considerable damage in Washington and Oregon to crops and vines planted on areas adjacent to timber lands occupied by these animals, and bureau representatives have demonstrated methods for their control.

Woodchucks have been a source of annoyance and loss to gardeners, truck growers, and farmers throughout New England and the Northern States west to Oregon and Washington. Following the introduction of alfalfa, clover, and succulent root crops in the Northwestern States, woodchucks have concentrated about these new sources of food supply, frequently traveling considerable distances to feed upon them. Their depredations have caused heavy losses, wide strips along the borders of fields often being completely destroyed. As the animals live under a great variety of conditions throughout the infested area, it has been necessary to develop methods adapted to meet the different conditions prevailing. Demonstrations are given or circulars outlining procedure issued as required by individuals or communities.

#### HOUSE RATS AND MICE.

The educational campaign to acquaint the public with the seriousness of the drain on the Nation's food resources through depredations of house rats and mice has been continued. This has involved considerable investigational work with a view to improving methods of poisoning and trapping the animals, devising effective means of excluding them from buildings and places where they could damage food or other stored property, and employing deterrents where other means of exclusion are impracticable.

In response to inquiries from points throughout the United States, bulletins, circulars, and other information regarding practical measures for destroying rats and excluding them through rat-proof construction and the use of deterrents have been supplied. Requests have

been received from military and naval officers in charge of camps, arsenals, and storage warehouses for the inspection of these places by experienced representatives of the bureau and for specific directions regarding procedure in destroying the rats or protecting property from their depredations. This was done at the naval base, Norfolk, Va.; at the arsenal and military camp located at Amatol, N. J.; and at the Picatinny Arsenal, Dover, N. J., where effective control measures were inaugurated and carried out. In other instances the situation was met by sending bulletins and furnishing other necessary information. State officials and public health officers of cities also appealed to the bureau for practical plans of organizing extended eradication campaigns and for suggestions regarding legislation or ordinances which should be put into effect with a view to complete and permanent rat control.

Interest on the part of State and municipal public health officials was stimulated by the appearance of bubonic plague at Beaumont and Galveston, Tex., and at Pensacola, Fla., with the possibility confronting them of its further spread. The rat serves as a carrier of fleas responsible for the transmission of the plague to human beings, and because of its extended movements from place to place within a city and from point to point throughout the country it becomes an active agent in disseminating this malignant disease. This situation, together with the fact that the rat is a notorious carrier of filth-borne diseases and a destroyer of property by contamination, also of food, feed, clothing, farm machinery, and harness and other leather goods, has emphasized the importance of carefully planned, thoroughly organized, and vigorously conducted campaigns for the destruction of all rats. Attention has been called to the fact that State laws and city ordinances should require all new buildings to be made rat-proof, and should also require the adoption of practicable measures for rat-proofing existing buildings, sewers, and water mains. Such action is of the utmost importance in any plan to eliminate the enormous losses of property and to remove the constant menace from disease due to the widespread abundance of house rats and mice.

Representatives of the bureau were detailed to visit Norfolk and Portsmouth, Va., and Baltimore, Md., to advise and assist the local officials in working out comprehensive plans for the organization of campaigns to destroy rats. Considerable assistance has also been rendered in urban and farming communities by local representatives of the bureau in connection with their regular field operations against rodent pests in the organized districts of the West. Emphasis has constantly been placed upon the absolute necessity for the rat-proof construction of buildings and storage places in both urban and rural communities as a means of obtaining permanent relief from rats, and upon the necessity for preventing the pests from finding harborage and having ready access to food supplies, as an essential preliminary step to the carrying out of effective measures for destroying them.

#### MOLES.

Many reports have been received from the Eastern and Middle States of damage by moles to lawns, garden and truck crops, and flower nurseries. While not rodents, moles are frequently confused

with them because of certain superficial resemblances in size, general outline, color, and pelage. Damage caused by moles has been, as in other years, closely associated with the work of mice, which frequently follow the mole runways. This damage by moles is often very serious, particularly in light sandy situations, where their lifting up of the surface soil injures the roots of plants and permits them to dry out, resulting in their death. The Townsend mole, the distribution of which is limited to the coast counties of Washington, Oregon, and northern California, has been destructive in vineyards, gardens, hay meadows, and lawns through its habit of burrowing near the surface of the ground and piling up mounds of dirt on the surface. Trapping moles with specially designed traps has proved to be the most practical way of combating them. Information regarding suitable traps and trapping procedure has been disseminated through bulletins and the press.

The value of moleskins was established among fur dealers through efforts of the Biological Survey, and methods of trapping the animals and preparing their pelts for market have been widely demonstrated throughout the infested territory. These demonstrations were conducted in cooperation with the public schools, the State extension services, and other agricultural agencies. Many successful boys' and girls' clubs were organized to trap moles and prepare their pelts for market, for the combined purpose of ridding the land of a pest and obtaining profits from the sale of the skins. As a result large numbers of these animals have been taken and their pelts marketed at good prices. Reports received from leading fur dealers indicate that the number of American moleskins marketed during the year showed an increase of approximately 20 per cent over the preceding year, representing a value of about \$60,000 for the raw furs.

#### PRODUCTION OF DOMESTIC RABBITS.

By the development in this country of a well-sustained interest in the production of domesticated rabbits there has been a rapid increase in the number of people who are raising them and in the number of animals produced. Many of the animals are used for home consumption, as the meat compares favorably with that of the domestic fowl and possesses high nutritive value. Rabbit meat has also come to be a popular item on the menu of hotels and restaurants wherever its good qualities have been demonstrated and an adequate supply can be furnished.

The cost of rearing rabbits is so low that they have been found a profitable adjunct to other lines of farm production. Many extensive plants have been established to raise them for the larger city markets, and great numbers also are being produced in the back yards of city residences. The pelts of these animals also have considerable value for felting and other manufacturing purposes. There has been a marked increase in the quantity of rabbit skins marketed and in the use of these skins by manufacturers of hats and of trimmings for coats and other wearing apparel. They are used in their natural color and are also clipped and dyed in imitation of more expensive grades of fur.

National and State rabbit breeders' associations are now well organized and are working actively for the development of the rabbit



industry as an important feature of the meat-production program of the country. Rabbit raising has also proved a popular phase of the activities of boys' and girls' clubs in many sections of the country. The Biological Survey has endeavored to stimulate this rapidly growing phase of animal production and guide it along practical lines. Farmers' Bulletin 1090, covering breeds of rabbits, plans for hutches, methods of feeding, breeding, marketing, and dressing rabbits and cooking the meat for food, with a section devoted to the treatment of the diseases of rabbits, was issued during the year. In order that inquirers might know where to obtain breeding stock and where to dispose of their output, lists of the principal rabbit breeders in the different States, and buyers of rabbits and rabbit skins have been maintained by the bureau.

Representatives of the bureau have kept in close touch with leading rabbit producers throughout the country and have inspected a number of the more important rabbitries and visited establishments devoted to the dressing and dyeing of rabbit skins. At the request of officials in charge, a representative of the bureau was also in attendance at the annual convention of the American Breeders and Fanciers' Association, held at Cleveland, Ohio, and at the rabbit show held at Baltimore, Md.

#### FUR-BEARING ANIMALS, THEIR PROTECTION AND PROPAGATION.

Many interesting features regarding the status of the fur industry have been developed as a result of investigations conducted during the year. Representatives of the bureau have visited the principal raw fur markets, including those in St. Louis and New York and in Montreal, Canada; and also have visited establishments engaged in the dressing and dyeing of furs and in the manufacture of fur garments. Studies have been made of conditions prevailing throughout the country as to abundance of wild fur-bearing animals, and maintenance of adequate breeding stock of the more valuable forms, with a view to the development of sound State and National policies in regard to trapping that would maintain the number of fur bearers at the maximum consistent with other agricultural and commercial interests. On invitation of Canadian officials, a representative of the bureau was detailed to attend a conference of the Commission of Conservation and the Advisory Board on Wild-Life Protection, at Montreal, February 19-20, for the purpose of discussing matters relating to the rearing, registration, and importation of silver and black foxes and other fur bearers in Canada and the United States, and of considering plans for the conservation, increase, and proper utilization of fur-bearing animals.

The value of pelts taken from fur bearers throughout the United States runs to a total of many millions of dollars annually without taking into consideration the large amount of labor and capital employed in their manufacture or the value of the product as it goes to the wearer.

North America has long been one of the most important regions of the world for taking the pelts of wild fur-bearing animals. More recently it has become one of the greatest world centers for the marketing and manufacture of furs. As illustrative of the extent of the fur business, it is estimated that there are approximately 18,000

people in New York City engaged in the various branches of the fur industry and that the capital invested there amounts to about \$200,000,000. During a period of 12 days in February, 1920, one firm in St. Louis sold peltries valued at \$27,000,000. A few days later a New York firm sold furs having only slightly less value, while in May the St. Louis firm listed furs for sale valued at \$30,000,000.

A survey of conditions throughout the country indicates that the supply of wild fur-bearing animals has decreased very materially during the last decade. This is doubtless due to the large number of people who, during a portion of the year at least, engage in trapping fur bearers, as a means of increasing their incomes. The exceedingly high prices which have prevailed for furs during the last few years have stimulated trapping activities to a remarkable degree, resulting in a serious depletion of the supply of wild fur-bearing animals in many sections of the country. The fur industry from trapper to manufacturer has developed to a point where it is worthy of the most careful consideration and the employment of all practicable measures to maintain the supply on a basis which will meet the requirements of the future and lay the foundation for the permanency and growth of the industry. Trappers, raw fur dealers, manufacturers, and Federal and State officials concerned with wild-life conservation work should unite in working out and establishing policies directed toward this end. This affects in a very material way present and future financial interests, besides providing fur garments to meet the demands of the constantly increasing number of persons who use them for physical comfort and for the satisfaction and enjoyment coming from wearing the more luxurious articles of apparel. While prices declined considerably at spring sales, it appears probable that owing to the world-wide decrease in the natural supply, prices will continue in future at a high level.

With a view to fostering and guiding the production of fur-bearing animals under conditions of domestication, the bureau has initiated and conducted experimental and practical studies of silver, black, blue, cross, and red foxes, fishers, martens, minks, skunks, and raccoons, and of animals which may be reared under semicontrolled conditions, including beavers and muskrats. These investigations have been conducted in part at the Experimental Fur Farm, near Keeseville, N. Y., on the ranches of successful fur breeders, and on marshes and streams under patrolled and natural conditions.

Carefully outlined studies are in progress of diseases that affect fur-bearing animals, both those of bacterial and those of parasitic origin. The specific causes and also the course and symptoms of such diseases are being investigated, and studies are being made of means of prevention and methods of treatment, practical ways of disinfecting pens, dens, and houses, and means by which they may be maintained in a sanitary and healthful state. Studies were continued of feeds and feeding practices with a view to economy of production and maintenance of health and vigor in the animals, and of soil, climatic, housing, and other conditions favorable to the production of furs having the highest marketable qualities. Studies are also in progress of fur quality and grade and the characteristics upon which these are based, including means of identifying accurately the kinds of fur that are now placed on the market under a great variety of trade names. The latter feature is of much importance

because of the skill with which inferior furs are now dressed and dyed in imitation of more valuable peltries.

During the year much information has been furnished inquirers through correspondence and the issuing of circulars and bulletins. An article entitled "Trapping on the Farm" was published in the Yearbook of the Department of Agriculture for 1919, and a manuscript for a department circular completed for publication on "Maintenance of the Fur Supply."

#### ECONOMIC ORNITHOLOGY.

As in the previous fiscal year, investigation of damage by various birds protected under treaty between Great Britain and the United States was a special feature of the work. Provisions of the migratory-bird treaty act authorize the Secretary of Agriculture to issue permits to kill any of the protected birds when found seriously injurious to agricultural or other interests. This is a wise and beneficent arrangement, for there is no doubt that the true interests of both bird protection and agriculture are furthered by facilities for the constant adjustment of the numbers of birds in relation to the supplies of food they may consume without detriment to man. When birds increase to such an extent that these supplies no longer suffice for them, and they make serious inroads on cultivated crops, control measures are justified, and it is fortunate that the department has at its command this indispensable part of a well-balanced program in economic ornithology.

Investigations of the economic relations of various groups of birds were continued during the year, the birds receiving most attention being the English sparrow, the vireos, yellow-legs, Wilson snipe or jacksnipe, hawks, and owls, and the redhead and scaup or bluebill ducks. A number of manuscripts were prepared for publication, those not mentioned elsewhere in this report being "The Crow in Its Relation to Agriculture" and "Community Bird Refuges," prepared for publication as farmers' bulletins; and as department bulletins, a report on the "Fish-eating Birds of the United States," "Food and Economic Relations of North American Grebes," "Food of American Phalaropes, Avocets, and Stilts," and "Food Habits of the Vireos."

#### MEADOWLARKS AND DOVES IN SOUTHERN STATES.

An investigation conducted during the year having demonstrated that meadowlarks are seriously destructive of sprouting oats and corn in South Carolina, an order was issued by the Secretary of Agriculture permitting aggressive measures against the birds from November 1, 1919, to April 30, 1920. Investigations of similar complaints against mourning doves were not conclusive.

#### ROBINS DESTROYING CHERRIES IN NEW YORK.

Complaints that robins do considerable damage in the commercial cherry-growing regions of New York, received both from individual fruit growers and from horticultural organizations, led to an investigation of the trouble. It was found that during the ripening season of small fruits robins were securing most of their sustenance from



them and the damage done amounted to about 10 per cent of the crop in the case of sour cherries and to 75 and even 100 per cent of sweet cherries. An order was therefore issued permitting the killing of robins from June 1 to July 15, guarded by numerous restrictions designed to prevent abuse of the permit, especially the killing of birds other than robins.

#### FISH-EATING BIRDS.

Partly from a general study of the economic relations of fish-eating birds and partly from a special investigation of the subject in Minnesota, Wisconsin, and Michigan, it became evident that certain fish-eating birds are a pronounced nuisance about fish hatcheries. The peculiar conditions at hatcheries that make the visits of fish-eating birds so destructive are that all fishes on the premises are of valuable kinds, and as they are confined in great numbers in shallow pools they fall easy prey to such birds. For these reasons birds which may be nearly harmless under natural conditions, preying chiefly on worthless fishes, the valuable kinds being in the minority in their habitat, become at fish hatcheries exclusively and often highly injurious. The birds which most often resort to fish hatcheries and which are named in an order of the Secretary of Agriculture permitting aggressive action against them at such places are the grebes, loons, gulls, terns, mergansers, the bittern, great blue, little blue, and green herons, and the black-crowned night heron.

One of these groups of birds, the mergansers, or fish ducks, have been accused of doing much damage in trout streams, particularly in Michigan. From three different investigations of the matter it has been learned that while mergansers occur in small numbers on most Michigan streams, they are very fond of trout and occasionally in severe winters concentrate on certain trout streams in such numbers that great destruction of these valuable fish must ensue. A permit, therefore, has been issued authorizing employees of the game, fish, and forest-fire department of the State of Michigan to control the number of mergansers.

#### DAMAGE BY OTHER MIGRATORY WILD FOWL.

In Back Bay, Va., and Currituck Sound, N. C., swans have increased considerably in numbers and much more in fearlessness as a result of the long term of protection they have enjoyed. They have changed their habits by coming to feed in small ponds in the marshes, a thing they rarely, if ever, did during the period in which they were hunted. The small ponds they visit are the chief attraction for the wild ducks on the premises of the various ducking clubs of the region, but the feeding operations of the swans, which may not be shot, soon deplete the stock of duck food in the ponds and render them unattractive to the ducks, the game chiefly sought by the clubs. Damage to shooting properties undoubtedly occurs, but owing to local complications which would result in remedial measures being misunderstood, and, further, to the very important fact that the region where damage occurs is the winter home of practically all the swans of eastern North America, and that preservation of the birds absolutely depends upon the treatment they receive there, it has thus far been deemed inexpedient to authorize control measures.

A report to the effect that wild geese are doing serious damage to fields of young grain, similar to other reports reaching the bureau periodically, came during the year from eastern Maryland. Upon investigation it proved baseless. The fact is that in most cases the cropping of young grain by geese really improves the stand by stimulating increased "stooling." Indeed, to secure this very effect, farm practice in some regions includes regular grazing of young grain by domestic stock.

#### CROWS DESTROYING ALMONDS IN WASHINGTON.

In the Goodnoe Hills region along the Columbia River in Washington crows are unbelievably numerous and have become very destructive to melon, apricot, and almond crops. An investigation made during the almond season showed that in two or three days the crows would consume the crop of one orchard and then move on to the next. Orchards were entirely stripped of nuts and the ground beneath strewn with almond husks and shells. Control experiments were at once begun and gratifying success was achieved. Poisoning operations, in which green almonds were used for bait with strychnine as the poison, killed many of the crows and struck terror into the flocks of these wary birds so that they deserted the orchards. Poisoning an orchard every 10 days has been found to give it immunity from crow damage.

#### INVASION OF THICK-BILLED PARROTS.

The thick-billed parrot is a Mexican species which at irregular intervals migrates from northern Mexico and appears in the United States in the Chiricahua and other mountain ranges near the border. It has been stated that last year these birds attacked feterita and other grains growing in the arable land in these mountains, which in recent years have been placed under cultivation. It was learned that the parrots entered the Chiricahua Mountains in large flocks during July, 1917, and remained in numbers until fall. On their arrival they began to feed upon cones of the Chihuahua pine, and when these were gone they turned their attention to acorns, of which there was an abundant crop. Though they often came into trees bordering clearings that contained cultivated fields or orchards, it was found that they had not damaged crops in any way in spite of many reports to the contrary. Nor did it appear that the pines or other trees on seeds of which they fed were harmed. From the data gathered it was established that at present the thick-billed parrot is to be considered a harmless species.

#### RELATION OF POISONING CAMPAIGNS TO BIRDS.

From time to time reports are received of numbers of birds being killed by poisoning operations directed against other animals. Such charges have been associated with the spraying campaign for the control of the gypsy moth in New England, with laying poisoned mashes for cutworms in various parts of the country, and with the poisoning operations of the Biological Survey against noxious rodents and

predatory animals in the Western States. Fortunately all fears as to significant destruction of birds in these campaigns have proved unfounded. In the last annual report of the bureau mention was made of an investigation connected with this problem which showed that quail certainly are not endangered by poisoning operations against ground squirrels in California. During the year two investigations were made to ascertain the relation of poisoning campaigns to birds. The first related to the use of arsenic and bran preparations in poisoning grasshoppers in North and South Dakota. Reports of birds being poisoned were investigated in the vicinity of Pierre, S. Dak., and of Dawson and Jamestown, N. Dak., and it was found that very few birds had succumbed, not enough to cause alarm. The second investigation resulted from reports of the destruction of large numbers of beneficial migratory birds in connection with an antivermin campaign in Pennsylvania. While no specific evidence was found to substantiate the reports, it was learned that unscrupulous persons in efforts to secure fur-bearing animals had distributed poison in a way that might cause the destruction of some wild-bird life. This practice was particularly dangerous to dogs and, if continued, even threatened the extermination of certain valuable fur bearers. Not all the animals that would suffer from this promiscuous poisoning could be considered vermin. The methods of crow control recommended by the State game and fish commission were not found to be dangerous to other wild birds.

#### FEEDING PLACES OF WILD DUCKS.

The bureau's work to aid in the improvement of feeding grounds of migratory wild fowl was continued during the year. Surveys were made of 26 lakes and ponds in Missouri, 5 in Michigan, and 1 in Tennessee, and reports including recommendations for improving conditions were made to individuals and associations interested. An extensive report on the marsh and aquatic vegetation of North Dakota, based on surveys of approximately 500 lakes, was completed during the year.

#### BIRDS AS ENEMIES OF INSECT PESTS.

Three special investigations of the relations of birds to outbreaks of insect pests have been undertaken during the year. For the last three years there have been serious infestations of grasshoppers in various parts of the Dakotas, the outbreak of the summer of 1919 being the most severe. In many places practically all vegetation was consumed and in others crops were so badly damaged that no attempt was made to harvest them. Information was obtained from the infested areas on the food habits of 27 species of birds, 25 of which were feeding on grasshoppers. From a third to all of the food of these birds was found to consist of grasshoppers, 19 of the species attaining the 100 per cent mark. The birds having the best record as grasshopper consumers were the lark sparrow, meadowlark, Franklin gull, Arkansas kingbird, crow blackbird, and common kingbird.

The Japanese beetle, an imported insect, has become thoroughly established in New Jersey, is very abundant, and does much damage.



Information regarding its bird enemies being desirable, a preliminary investigation was made. The kingbird, starling, meadowlark, crow blackbird, cardinal, and catbird were found to feed upon the pest. The investigation will be renewed the coming year.

As the fiscal year closed, an investigation was under way in Massachusetts to determine the relation of birds to the European corn borer, an insect that is arousing great apprehension among eastern agriculturists.

#### COOPERATIVE STUDIES OF BIRD FOOD.

Examinations of special collections of stomachs of birds for the benefit of individuals and organizations requiring definite information on the food habits of birds at certain localities and seasons, long a minor feature of the work in economic ornithology, were unusually numerous during the year. The material examined was donated to the bureau, thus passing into its general collection. Among the collections examined in this way were a series of wild-duck stomachs from Massachusetts, Michigan, and Alaska; one of hawks from New York; owls from New Jersey; owls and woodpeckers from Oregon; quail from New York and Georgia; crossbills from Indiana; rosy finches and Canada jays from Yellowstone Park; rosy finches and ruffed grouse from British Columbia; and miscellaneous birds from New Mexico and Peru.

#### BIOLOGICAL INVESTIGATIONS.

With the resumption of peace conditions and the return to the service of several members of the scientific staff from overseas duty the work of the Division of Biological Investigations has returned to normal and during the year developed certain new activities.

Field and laboratory work has been conducted along lines helpful to other activities of the bureau, including the enforcement of the migratory-bird treaty act and of the Lacey Act, which regulates the importation of birds and wild mammals and interstate commerce in game, administration of mammal and bird reservations, general conservation of game mammals and birds, and the lines of work bearing upon the economic relations of mammals and birds to agriculture, forestry, and stock raising. Progress has been made in adding to and arranging the various card indexes recording information on the distribution, abundance, and habits of North American mammals and birds. These files contain a large volume of data collected from all possible sources, including the manuscript reports of field parties of the bureau, notes gleaned from correspondence, reports from other bureaus, scientific institutions, and innumerable private individuals, abstracts from publications, and the results of examination of specimens submitted by colleges, museums, and individual collectors throughout North America. These files have become increasingly valuable from year to year and have enabled the bureau to become a clearing house for information regarding the wild birds and mammals of this continent. Thousands of letters are annually written in response to inquiries received from all parts of the country on these subjects.

## DISTRIBUTION AND MIGRATION OF BIRDS.

The work on bird migration has been carried on along lines followed during previous years. The effect of the war is still apparent in the lessened number of persons able to cooperate with the Survey in gathering data on bird migration, but an improvement is noticeable. As a result of special efforts it is expected that the number of volunteer observers will be greatly increased during the next year. Reports on bird migration were received from more than 250 observers, and many of them contained both spring and fall records. Progress has been made in abstracting records from published sources, and the work of copying the field notes of the various members of the Survey has been brought up to date. The number of record cards in the distribution and migration files, including bibliography, is now about 1,400,000. These files are in constant use in connection with the work of the bureau and in replying to correspondence.

No general publications have been issued during the year, but the following are nearly completed: "Distribution and Migration of North American Terns and Their Allies," "Distribution and Migration of North American Grebes, Loons, and Auks," and a circular of instructions for bird banding.

## BIRD BANDING.

As an aid to the study of the migration of birds the work of the American Bird Banding Association was taken over and active preparations for carrying it on have already been made. It is planned to develop the investigations along two principal lines—the banding of waterfowl on their breeding and wintering grounds and the systematic trapping and banding of the smaller land birds. Results already obtained by the independent prosecution of the last-named line of work by a few private individuals have shown that this method of studying bird migration affords information of great importance: for instance, knowledge of the routes followed by individual birds in traveling between their wintering and breeding grounds. It is certain that the systematic and energetic prosecution of this method of research by a central agency which will enjoy the cooperation of many independent observers will result in the accumulation of a mass of valuable information on the movements of birds and will throw light on many obscure problems connected with this interesting study. During the few months that this work has been directed by the Survey it has attracted wide attention from both sportsmen and naturalists throughout the country. Cooperation has already been promised by most of the State game commissions and by many private individuals and organizations so situated as to be able to furnish substantial assistance.

## BIRD COUNTS.

Reports of the sixth annual series of counts of birds breeding on selected areas, mainly on different types of farm lands in various parts of the United States, were received from about 30 observers, who reported on 45 separate areas. Many of these counts were made on areas reported on during previous years. This part of the work

of the bureau, like that of bird migration, has suffered from war conditions; but special efforts are being made to enlist the services of new observers and to interest old observers in resuming their co-operation, thus adding to the value of this important work. A third report on bird counts in the United States, detailing the results obtained since the last publication on the subject, is in course of preparation, and it is believed that its appearance will stimulate the interest of observers and result in a large increase in the number of reports received.

#### BIOLOGICAL SURVEYS OF STATES.

Field work has continued in Florida, Montana, North Dakota, Washington, and Wisconsin in furtherance of the biological surveys which have been in progress in those States during past years.

During January and February a party investigated conditions along the Gulf coast of Florida from Choctawhatchee Bay south to the Chassahowitzka River, particular attention being paid to the resorts of wintering ducks and other waterfowl.

In Montana, the valley of the Missouri and the bordering plains and mountains, from the mouth of the Milk River westward, were investigated during the early summer. In the latter part of the summer explorations covered the Little Rockies, Moccasin Mountains, Big Belt Mountains, Little Belt Mountains, and the Castle Mountains.

In North Dakota an investigation was made during September and October with special reference to the hibernation and food-storing habits of various small mammals. This resulted in the accumulation of considerable data regarding the food habits of several species of economic importance.

In Washington explorations were conducted from early in July to late in September, 1919, mainly in the region of Mount Rainier National Park, work on this particular area being undertaken with the cooperation of the National Park Service, the State College of Washington, and the Washington State Normal School. During this investigation as thorough a study as possible of the zonal and faunal conditions of the region was made. A detailed report on Mount Rainier National Park, including a topographic description of the region, results of studies of the life zones, and extensively annotated lists of the birds and mammals, is well advanced in preparation and is expected to be published by the National Park Service. During the remainder of the fiscal year an assistant of the Survey was continuously engaged in investigating faunal conditions in various parts of the State.

In Wisconsin investigations were conducted from July 1 to September 20, mainly in the northwestern part of the State, special attention being given to the Apostle Islands, in Lake Superior, the fauna of which was practically unknown. This resulted in the discovery of many interesting facts concerning the detailed distribution of the species on the various islands. As during previous years, the work in Wisconsin was conducted in cooperation with the Wisconsin Geological and Natural History Survey. After the completion of this work, early in September, a special investigation of the distribution and habits of beavers in the northern part of the State was



conducted in cooperation with the Wisconsin Conservation Commission.

"The Mammals of Panama," prepared by an assistant biologist of the bureau as one of the results of a cooperative biological survey of the Canal Zone conducted in 1911 and 1912, was published by the Smithsonian Institution during the year. Other manuscripts based on field work of the Biological Survey completed, but not yet published, include the "Mammals of Alabama," "Mammals of New Mexico," "Mammals of North Dakota," "Mammals of Wyoming," "Birds of Alabama," "Birds of New Mexico," and "Birds of Texas." Partial arrangements have been effected for the publication of the three last-mentioned reports by the States interested, and it is hoped that those of Alabama and New Mexico will soon be issued. Technical studies of several groups of North American mammals have also been conducted during the year, and the results of one of these, a revision of the pikas, or conies, was completed.

#### BREEDING GROUNDS OF MIGRATORY WILD FOWL.

In continuation of the investigations of the breeding grounds of ducks and other waterfowl on the Great Plains, which have been prosecuted annually for several years past, the lakes of North Dakota were visited during July. In this section a great increase in the number of ducks as compared with previous years was noted.

In the spring of 1920 arrangements were made with the cooperation of a private individual interested in the distribution of waterfowl to investigate the breeding grounds of ducks and other species of migratory game birds in the delta of the Athabaska River in central Canada. Owing to the unusually favorable conditions in this large area of marsh lands it is frequented during the breeding season by vast numbers of waterfowl which winter to the southward, principally in the United States. This section is probably the most important single area resorted to by breeding waterfowl in North America. A party led by an assistant of the bureau was engaged in an intensive study of conditions in this area throughout the spring and summer. In addition to conducting studies of the abundance, local distribution, and breeding habits of all the species nesting there, it is purposed to band as many as possible of the young birds as an aid to determining the lines of flight and the wintering grounds of the various species. The results obtained by this party will undoubtedly prove of great interest and value in the study of bird migration and in the intelligent administration of the migratory-bird treaty act.

During the year considerable publicity was given to the suggestion that migratory-bird treaties similar in character to that between the United States and Great Britain be negotiated with the countries lying south of our border, including South America. The Senate, on February 9, 1920, passed a resolution asking the President to consider the negotiation of such treaties. To this the President replied on March 13, transmitting letter from the Secretary of Agriculture, to the effect that lack of definite information concerning conditions affecting migratory birds in Mexico and other Latin American countries renders it unwise to take up the matter of treaties for bird protection until sufficient facts are available to indicate their justification. It is known that a serious destruction of migratory game

birds occurs every winter in Mexico, but conditions in that country have not been propitious for a migratory-bird treaty.

A considerable number of our important waders and shorebirds, especially golden and black-bellied plovers, winter in Argentina and adjacent countries, and their future conservation may depend on conditions attending the rapid development of agriculture in that remote region. In order to have the necessary first-hand information regarding this, an assistant biologist was detailed to proceed to Argentina and adjacent countries in time to witness the arrival there of our migratory wild fowl during their southern migration in the summer of 1920 and to continue his investigations relating to these birds in their winter home until they return northward again in the spring of 1921. He sailed for Buenos Aires on May 29 and should bring back much valuable information bearing on the future of many of our well-known species.

#### WILD LIFE IN NATIONAL PARKS AND NATIONAL FORESTS.

Late in September, 1919, a representative of the bureau visited the Black Hills of South Dakota to investigate the topography and food resources of an area which has been proposed as a game and bird refuge, to determine its fitness as a reservation for the protection of wild life.

An investigation was begun late in October in cooperation with the Forest Service to ascertain the conditions affecting the herd of elk at different seasons on the Sitgreaves National Forest, Ariz., variously estimated to contain from 300 to 500 animals. These are the progeny of a number of elk introduced from the Yellowstone Park region several years ago. The work was resumed in January, when the winter range and the approximate number of elk composing the herd were determined. Another trip was made to the region during the latter part of June to ascertain the summer range of the herd and to secure data on which to base final recommendations regarding the extent and approximate boundaries of a proposed game refuge. This investigation was still in progress at the close of the fiscal year.

During the first half of April an investigation of the condition of the elk wintering in the Jackson Hole region was made, special attention being given to certain areas in the Hoback Valley, along the slopes of the foothills bordering Jackson Valley on the east and in the valley of the Gros Ventre, all within the confines of the national forests, on which, by virtue of arrangements made in 1917 with the Forest Service, grazing by cattle was restricted in order to conserve sufficient forage for wintering elk. Further joint investigation by this bureau and the Forest Service is planned during the summer. The National Park Service will also have men in the field in order that the three bureaus interested in the Yellowstone elk herds may work effectively for their conservation. A new edition of the circular of information concerning Yellowstone National Park, which is issued annually by the National Park Service and which appeared in the spring of 1920, contains revised lists of the mammals and birds of this area, contributed in part by a field naturalist of this bureau. In addition, a comprehensive treatise on the mammals of Yellowstone National Park is in the hands of the National Park



Service for publication, and a large manuscript map showing the life zones of the Yellowstone National Park and the region adjoining it on the south was prepared for the use of the National Park Service. Lists of a few characteristic birds and mammals of Mount Rainier National Park have already been published by the National Park Service in its circular of information, and, as already stated, a detailed report on the region is well advanced in preparation.

#### RELATION OF RODENTS TO FOREST PRODUCTION.

Progress was made in experiments being conducted to secure information concerning damage to crops and forage by injurious rodents, instituted in the spring of 1918 in several western States, notably Arizona and Colorado. By means of quadrats established on grazing areas, some of these plats being fenced and others unfenced, the damage inflicted by the rodents which abound there is measured. A preliminary report on the results of these investigations is in preparation. A department circular (No. 59) entitled "Field Studies of Mammalian Life Histories," which outlines the procedure to be followed in studying the habits of these important animals in order to obtain the best results, was issued in October.

#### BIG-GAME AND BIRD RESERVATIONS.

Federal big-game and bird reservations in charge of the Biological Survey are now 75 in number. Four are big-game preserves, 70 are bird reservations, and 1, the Niobrara, created as a bird reservation, is used for both birds and big game. Included in the number is a small bird reservation near Fort Myers, Fla., of two islands containing rookeries and breeding grounds of several species of herons, established by Executive order of July 1, 1920, and known as the Caloosahatchee bird reservation, in the river of the same name. On June 30, 1920, the big-game reservations contained a total of 427 buffalo, 384 elk, 60 antelope, and 27 deer, an increase in each species over last year. The total number of buffalo now in the Government's various herds exceeds a thousand head, of which about half are under the charge of this department.

The boundaries of the Niobrara Reservation were modified during the year by the inclusion of a narrow strip of bottom land on the west boundary along the Niobrara River. A bill affecting the boundaries of the Klamath Bird Reservation, approved on May 27, 1920, among other things authorizes the Secretary of the Interior to determine which lands are chiefly valuable for a bird preserve and which are chiefly valuable for agriculture, and to eliminate and open to settlement the agricultural areas. The measure is likely to result in the modification of the southern boundaries of the reservation and in the elimination of swamp lands, which, however, have not been utilized by the birds for several years.

During the summer an investigation was made by a representative of the bureau, in cooperation with the secretary of the American Bison Society, for the purpose of selecting a tract in eastern Oregon suitable for a refuge for sage grouse and antelope, and as a result one was selected east of Warner Lake and extending from Lake County, Oreg., to Washoe County, Nev. Some opposition to the



creation of this reservation having developed, reexamination of the project indicates that the area may be materially reduced without serious injury to the purpose for which it is intended.

The unusual drought of 1919 was responsible for several fires, particularly on the National Bison Range, in Wind Cave Park, and on the Klamath Bird Reservation. No serious damage was done on any of the big-game refuges, but on the Klamath Reservation the fires burned over a considerable area of tule land before they were extinguished by autumn rains.

#### BIG-GAME RESERVATIONS.

*Winter Elk Refuge, Jackson, Wyo.*—This reservation thoroughly justified its existence this year in saving the southern Yellowstone elk herd from practical extermination by starvation. Throughout the summer of 1919 a severe drought prevailed in the northern Rocky Mountain States, which prevented the growth of forage on the range and greatly reduced the output of hay. This was followed by an almost unprecedentedly long and severe winter, beginning with fierce snowstorms, which drove the elk out of the high mountains the last of October, and continuing until the end of April.

The hay crop for 1919 on the elk refuge, with hay held over from the previous year, made a total of about 850 tons on hand at the beginning of winter. The State game warden of Wyoming provided about 500 tons and a carload of cottonseed-oil cake. As it became necessary to feed elk on the refuge much earlier than usual, it was plain that unless more hay was provided the last months of winter would see the animals perish by thousands. The Secretary of Agriculture granted the Biological Survey authority to expend the sum of \$45,000, if necessary, in the purchase of hay to meet this emergency. Owing to the urgent need of hay for stock, it was difficult to secure any for the elk, but early in January 573 tons were purchased, hauled 30 miles on sleds, and fed to the elk during the later months of winter, at a total cost of \$36,271.50. This provided sufficient hay to feed until the end of the emergency, April 20. About 8,000 elk were reported as having been fed on the refuge and in the valley below during a considerable period late in the season. The availability of the necessary hay to feed the animals at this critical time kept them off the winter range in that district, leaving the scanty forage on it to maintain the elk which did not descend to the feeding grounds.

Early in the fall it was estimated that there were about 17,000 elk in the southern herd, of which approximately 2,000 were killed by hunters. About 15,000 entered the winter, and a careful estimate gives 13,000 as the number of survivors which were doing well late in May. The loss of approximately 2,000 during the winter of 1919-20 was only a little above normal despite the severity of the winter and the scantiness of forage.

In connection with the maintenance of the elk on the Winter Elk Refuge it may be stated that the hay crop for 1919 amounted to only 314 tons, which was grown, cut, and stacked at an average cost of \$4.09 a ton. This is a higher cost than the average in ordinary seasons, owing to the scanty crop caused by the drought. Hay land added to that on the refuge sufficient to raise the total yield in ordinary seasons

to from 1,000 to 1,200 tons would provide a surplus sufficient to meet any emergency and insure the perpetuation of the southern elk herd. It is imperative if the interests of the southern herd are to be reasonably safeguarded that additional hay land adjoining the present refuge be purchased at an early date.

*National Bison Range, Moiese (near Dixon), Mont.*—During the past year substantial improvements were made at the National Bison Range, including the construction of a residence for an assistant warden. At certain times of the year, particularly during the months when there is danger from fires, it is essential to have an assistant warden regularly employed on the range, and at other times extra assistance is necessary to enable the warden to perform his duties efficiently. Owing to the drought of 1919 unusual pressure was brought to bear on the department to open up part of the range for grazing, but on account of the danger of communicating cattle diseases to the buffalo it was considered unwise to assume the risk of jeopardizing the herds for which the range was established. Grass fires in August and September at first threatened to do considerable damage, but through the activity of the warden and the assistance furnished by the Reclamation Service and the Indian Agent they were extinguished after a few hours with only slight losses. A fire in the first week in August burned over about 1,000 acres.

The animals on the range now number nearly 600 head, as follows: Buffalo, 332; elk, 200; antelope, 40; and mule deer, 19. The herd of buffalo is now the second in size belonging to the Government and is fourth in point of numbers of those in the United States. The antelope show only a slight increase, but the losses have been smaller than in the previous year and it is hoped that the herd will increase more rapidly. Arrangements were made to secure a few white-tailed deer, and efforts will be continued during the coming year to establish a small herd on the reservation.

*Wind Cave National Game Preserve, S. Dak.*—The inclosure of 4,160 acres on this reservation now contains about 60 buffalo, 105 elk, 20 antelope, and 2 deer. As in the case of the Montana range and the elk refuge, the past winter proved unusually severe, but the losses were slight. The number of antelope remains about the same as last year, the natural increase being unfortunately offset by the loss of 7 animals.

It is highly desirable that the boundary lines on the north and west of the game preserve be modified by the addition of a small area in the adjoining national forest in order to straighten the lines and provide for future permanent boundary fences before the land becomes alienated or settled. Shelters, benches, tables, and other conveniences should also be provided for the comfort of visitors who wish to eat lunch or spend the day at the game preserve.

*Sullys Hill Game Preserve, N. Dak.*—Substantial progress has been made during the year in the improvement of this reservation, including the approval of plans for the construction of a women's rest house and for covered pavilions for protection during sudden storms. Plans for the extension of automobile roads from Devils Lake contemplate the construction of a road through the park immediately adjoining the lake shore. In case this improvement is consummated, the preserve will be readily accessible by automobile



or team from Devils Lake and undoubtedly the number of visitors will be greatly increased. This reservation is becoming increasingly popular among the people of the surrounding region and the improvements being made there will add much to their comfort. The herd of seven buffalo, the nucleus of which was presented by the Portland City Park, has done remarkably well considering the change in climate; besides these animals there are on the preserve 32 elk and 6 deer, an increase of 10 over last year.

*Niobrara Reservation, Valentine, Nebr.*—As already stated, the boundaries of this reservation were modified during the year by the addition of a strip which will afford protection to grouse and other birds. There are now in the inclosure 28 buffalo and 47 elk, 2 mule deer, and 4 Canada geese.

During the past winter a serious menace to the reservation developed in the leasing of four private holdings within the reservation boundaries and of the school section in the central part to certain interests which insisted on pasturing sheep and driving them to and from the river for water. This school section, belonging to the State, was leased for sheep grazing and a large flock of sheep was pastured there for some weeks, causing considerable destruction of the forage and expense to the department. Negotiations are now under way with the State authorities whereby it is hoped that danger of further grazing on the school section can be eliminated, but so long as the four private holdings remain within the boundary lines, there will be danger of a recurrence of the trouble. Plans are under consideration to increase accommodations for visitors and thus add to the public usefulness of this reservation.

#### BIRD RESERVATIONS.

On 13 of the 70 bird reservations paid warden service was maintained throughout the year, viz. Key West, Mosquito Inlet, Pelican Island, and Passage Key, Fla.; Minidoka, Idaho; Breton Island, La.; Big Lake, Ark.; Cold Springs, Klamath Lake, and Lake Malheur, Oreg.; Belle Fourche, S. Dak.; Strawberry Valley, Utah; and on the Hawaiian Islands Bird Reservation. On several other reservations warden service was maintained during the nesting period, the hunting season, and at other times when trespass was liable to occur. Through cooperation of the Reclamation Service protection is afforded on the more important of the bird reservations located within reclamation projects. Cases of trespass during the year have been comparatively few, the more important occurring on Big Lake and at Mosquito Inlet. Several arrests were made and convictions were secured in most cases.

*Mosquito Inlet Reservation, Fla.*—On the Florida reservations conditions have been most satisfactory at Mosquito Inlet, on the east coast. An interesting feature of this reservation is the recent voluntary establishment of a heron rookery within the limits of the town of New Smyrna, where the first birds nested in the spring of 1918. This year reports indicate the presence of several thousand young and old birds all in good condition. The colony is well protected and bids fair to become within a few years one of the important heron rookeries of the State. An unusual number of pelicans were noticed about the reservation during the winter of 1919-20, possibly due



in part to unsatisfactory breeding conditions at Pelican Island, a few miles farther south. A typical case of violation of the act protecting birds on bird reservations occurred on December 14, 1919, when a yacht passed through the reservation bearing three nonresident sportsmen who wantonly shot a number of gulls, terns, and pelicans. One of the offenders was subsequently arrested at Miami, warrants were obtained for the other two, and the case was set for trial at the next term of the Federal court at Jacksonville. This act of vandalism occurred within sight of a large sign warning against shooting on the reservation; such acts occur occasionally, but each instance has been followed by prompt arrest and conviction.

*Pelican Island Reservation, Fla.*—The birds on Pelican Island arrived August 13–14, earlier than usual. Eggs were laid in the first week in September, but a storm on the 28th destroyed most of them. The first young were hatched during the last week of October, but storms and high water on November 17–18 practically swept the island clear of all but a few nests, only those on the higher parts escaping, and these were later abandoned. Later unfavorable conditions in February were followed by an abandonment of the nests about March 1. Thus the season which began a month earlier than ordinarily was peculiarly unfavorable and fewer birds than usual were reared.

*Passage Key Reservation, Fla.*—Two large observation towers were erected on Passage Key at the mouth of Tampa Bay by Army engineers during the spring of 1920 in the only grove of mangroves on the island, and the tops of the trees were cut off and the nesting birds disturbed and driven away. The construction of these towers proved so detrimental to the interests of the reservation that arrangements have been made with the War Department to prevent future occurrences of this sort. Passage Key has suffered severely during the last few years from erosion and the effects of tropical storms. The island is now less than half its original size, but still includes the breeding grounds of gulls, skimmers, least terns, and several species of herons. Every effort is being made to afford the birds protection on the limited area now available for nesting sites.

*Tortugas Keys Reservation, Fla.*—A severe hurricane which visited the reservation in September did considerable damage both to the warden's quarters and to the birds. A lean-to kitchen was completely demolished, the porch and other parts of the headquarters damaged, and the warden himself had a narrow escape from serious personal injury. After being marooned on the island for three days, practically without food, he was rescued by the naval tug from Key West. Many of the birds were overwhelmed by the storm, but it is impossible to ascertain the exact number. Warden service was reestablished in June, and arrangements have been made for necessary repairs to the quarters. The number of terns on this reservation has increased to a point where it will be necessary, after the breeding season is over, to provide further nesting sites and material by planting bay cedars. These bushes were formerly numerous on the island, but many of them were destroyed some years ago by storms and high water.

*Big Lake Reservation, Ark.*—The location of proposed drainage canals on the north and east sides of this reservation has been ad-

justed in a way which, it is hoped, will prevent damage to the reservation in the course of the development of the adjoining drainage districts. Owing to the unusual depth of water during the past winter, mallards and other ducks did not remain in as large numbers as usual, but with the lowering of the water the birds are likely to return next year in their usual numbers. Poaching has been less frequent, and the establishment of regular warden service and the enforcement of the law have resulted in general acceptance of the restrictions necessary for the maintenance of the reservation.

*Klamath Lake Reservation, Oreg.*—Conditions on the Klamath Lake Reservation have been very unsatisfactory, owing to a combination of circumstances over which this department has had no control. The tule fire, which was started in the spring of 1919, continued to burn over the southern part of the reservation until extinguished by early autumn rains, and a considerable area inside the boundary lines was rendered unfit either for occupation by the birds or for immediate agricultural use. The water table on the lake has been lowered several feet by closing the gates which control the inflow from the Klamath River. This action, made under agreement with the water users' association, has uncovered large areas of alkali mud flats without thus far benefiting the settlers adjoining the lake or opening up additional lands suitable for agriculture. A soil survey made during the summer of 1919 has shown that the lands thus uncovered have little, if any, agricultural value. The act authorizing the elimination of certain agricultural lands from the reservation, recently approved, should result in determining the permanent boundaries of the reservation. If an agreement can be made for raising the water level slightly, Klamath Lake can still be made one of the most important bird reservations in the West; otherwise its future as a refuge is seriously jeopardized.

*Malheur Lake Reservation, Oreg.*—Conditions at Malheur Lake have been as unsatisfactory as those at Klamath. The unusual drought which prevailed in eastern Oregon in 1919 caused the lowering of the water level and the diminution of the breeding grounds of the birds. The uncertainty of the title to some of the lands adjoining and within the boundary lines of the reservation seriously impedes any effective development. Some action is imperative to clear up the question of jurisdiction and enable the department to fix a stable water level and develop the reservation in a way to afford protection to the birds.

The most serious menace to this great breeding place for wild fowl lies in the appropriation of water, heretofore flowing into the Malheur Lake basin through the Silvies and the Blitzen Rivers, for the development of agricultural lands at a distance from the lake. This has already reached a point which leaves the future of the lake very doubtful. The constant diversion of this water supply means the drying up of the lake and the reduction of its basin to a bare alkaline mud flat like that now marking a large part of the Harney Lake bed. When this occurs it will make absolutely worthless the near-by forage-producing lands now growing natural feed with a substantial income on a valuation of \$1,000,000, and will leave the residents homeless.



A soil survey made of the lands about the borders of the lake during the summer of 1919 by an expert from the Bureau of Soils developed the fact that they are too strongly charged with alkali to have any agricultural value other than the production of the natural forage crop.

*Hawaiian Islands Reservation.*—Renewed requests have been received for permission to establish fishing stations on some of the islands of this reservation, but it is obvious that this would result in the practical extermination of the bird life which this reservation was established to protect. The bureau is strongly averse to any such occupation of these islands.

## MIGRATORY-BIRD TREATY AND LACEY ACTS.

### PROTECTION OF MIGRATORY BIRDS.

The constitutionality of the migratory-bird treaty and the act of July 3, 1918, to give it effect was sustained on April 21, 1920, by decision of the Supreme Court of the United States in the case of the State of Missouri *v.* Ray P. Holland, United States game warden, an action brought to restrain Federal wardens from enforcing the Federal law in Missouri. An application by the State of Missouri for a rehearing was denied on June 7, 1920. Six Federal judges—in Arkansas, Florida, Louisiana, Missouri, Montana, and Texas—had previously upheld the validity of the act.

During the year the number of United States game wardens was increased from 15 to 31, but the warden force is still far below the number needed for the effective enforcement of the law. At various times during the year it became necessary to place on active duty 65 deputy wardens, who rendered valuable services and greatly assisted in reducing violations. Cooperation was also extended by 245 deputy wardens, who received a nominal salary of \$1 per annum: these Federal deputies in most instances occupy positions as State deputy game wardens.

Owing to the small number of wardens, it became necessary during the spring migration to concentrate the force in the Middle Western and South Atlantic Coast States, where violations were most numerous, and as a result of these concerted efforts many violators, including some who had for a long time successfully evaded detection, were apprehended.

United States game wardens and deputies reported 537 violations: 423 convictions were secured, in which fines were assessed ranging from \$1 to \$500 and aggregating more than \$8,900. In the large majority of cases the fines were supplemented by the imposition of costs, which in most instances equaled, and in others exceeded, the amount of the fines. Five cases were dismissed by Federal judges: 56 cases were nolle prossed: grand juries returned no bills in 56 cases: 2 trials by juries resulted in acquittals: 2 prosecutions were terminated by death of defendants: and 8 prosecutions were abandoned by United States attorneys because of insufficient evidence. Twenty-eight cases of trivial or technical character were not reported by the bureau for prosecution.

Convictions were secured in Federal courts as follows: Alabama, 4; Arizona, 2; Arkansas, 44; California, 1; Connecticut, 1; Delaware, 2;



District of Columbia, 3; Florida, 28; Georgia, 18; Illinois, 28; Iowa, 16; Kansas, 1; Kentucky, 17; Louisiana, 28; Maine, 2; Maryland, 35; Massachusetts, 1; Michigan, 3; Minnesota, 20; Mississippi, 3; Missouri, 27; Montana, 5; Nebraska, 18; Nevada, 1; New Jersey, 31; New York, 10; North Carolina, 6; North Dakota, 1; Ohio, 4; Rhode Island, 5; South Carolina, 2; South Dakota, 10; Tennessee, 3; Texas, 26; Virginia, 5; Washington, 7; and Wisconsin, 5.

A libel proceeding against 5,736 reedbirds was filed in the Supreme Court of the District of Columbia, and by order of the court the birds were given to the Walter Reed Hospital for use as food. Five libel proceedings against aigrettes were had in Alabama and the plumes condemned by court order.

Plumes of migratory birds, of an estimated value of \$12,500, possessed, offered for sale, or sold in violation of the law, were seized during the year. Some of these were released to the bureau by the parties from whom seized, while others were turned over to it by court order. Numerous seizures were made of migratory game birds illegally killed or possessed, and most of such birds have been disposed of by the bureau, with the consent of the person from whom seized, by gift to hospitals and charitable institutions for use as food.

In many cases substantial fines have been imposed, but in others the convicted parties have been given their freedom on payment of nominal fines. One persistent offender, charged with transporting quail and other game birds from Massachusetts to New York, but which were seized in transit at New Haven, Conn., was convicted and sentenced to 3 months in jail. A violator charged with unlawfully collecting eggs of migratory birds was arraigned in the Federal court for the eastern district of South Carolina and fined \$30 and costs, and in addition sentenced to one week in the Charleston County jail. In Michigan in 2 cases involving the purchase and sale of wild ducks fines of \$250 and \$500 were imposed; in Florida in 2 cases involving the possession and sale of aigrettes, each violator was fined \$250, and the plumes, worth several thousand dollars, were confiscated and condemned; one offender arraigned in Federal court at Sioux Falls, S. Dak., charged with selling wild ducks, was fined \$200; while one arraigned on a similar charge at Baltimore, Md., was fined \$250 and costs. A case involving hunting and killing geese in close season resulted in a fine of \$100 in the Federal court in New Jersey: the offender in this case was convicted in Federal court last year and fined \$5, but at the trial for the second offense he was warned by the judge that another repetition would merit a jail sentence. At Milwaukee, Wis., the Federal judge imposed fines of \$100 each against 3 persons charged with shooting wild ducks after sunset. Many fines ranging from \$25 to \$100 were also imposed by judges in other States.

The airplane also had its place in the pursuit of game, and as a result of resort to this illegal means of hunting migratory game birds five violators were apprehended, one of whom has been convicted and fined \$50 in Federal court at Sioux Falls, S. Dak., this being the first conviction under the Federal law for a violation of this character; the other four cases are still pending.

Several prosecutions on charges of hunting from motor boats resulted in convictions and the imposition of substantial fines. One person charged with hunting from a motor boat entered a demurrer

on the ground that the Federal law was unconstitutional, but the demurrer was overruled and a fine assessed.

Very gratifying reports are still being received from nearly every section of the country of the ever-increasing number of migratory birds as a result of Federal protection. Sportsmen enjoyed the best hunting season of many years, and in a large number of sections the daily bag limit was easily secured. It is particularly gratifying, especially to the sportsmen of the Middle West, to know that sand-bar shooting in the Mississippi River, long since destroyed by hunters operating from motor boats, has been restored as a result of the ban placed on motor-boat hunting.

During the year 783 persons were authorized to collect and 92 persons were authorized to possess migratory birds for scientific purposes, 58 persons were authorized to capture and 1,343 persons were authorized to possess migratory waterfowl for propagating purposes. Only a small percentage of the persons to whom propagating permits were issued are engaged in breeding waterfowl for food purposes, many of the birds possessed being held merely for use as decoys or for ornamental purposes.

In New Jersey the game law was made to conform to the Federal regulations, and in Kentucky laws were enacted in conformity with the Federal regulations with respect to the open seasons for waterfowl and Wilson snipe, the bag limits on all species of migratory birds except plover and yellow-legs, and the provisions prohibiting hunting between sunset and half an hour before sunrise. The seasons for waterfowl and most other species of migratory birds now substantially conform to the Federal regulations in 30 States.

On October 4, 1919, an order was issued by the Secretary of Agriculture permitting meadowlarks to be killed in South Carolina when necessary to protect grain crops. Other orders were issued as follows: On October 24, 1919, permitting certain species of birds to be killed at fish hatcheries when found to be injurious to fish life; on July 30, permitting rice growers and members of their immediate families and bona fide employees in the counties of Butte, Colusa, Glenn, Sutter, Yolo, and Yuba, Calif., to kill wild ducks when necessary to protect the rice crop from the depredations of such birds; and on November 13, a similar order applying to the counties of Arkansas, Lonoke, and Prairie, in Arkansas; on March 30, 1920, relating to the issuance of permits effective in New York when countersigned by the State Conservation Commission, allowing the killing of robins when necessary to protect the cherry crop; on April 29, permitting the killing or trapping by State game wardens in Michigan of certain birds found to be injurious to valuable fish life; and on the same date a similar order authorizing State game wardens of New Hampshire to kill or trap certain birds on streams closed to fishing.

During the early part of 1920 it became evident that certain amendments of the migratory-bird treaty act regulations were needed. These were formulated in the bureau, and together with other matters relating to game conservation were considered by the Migratory-Bird Treaty Act Advisory Board which met in Washington on June 21 and 22. The opportunity for the personal exchange of ideas between officials of the bureau and the advisory board proved to be so advantageous that it was planned that, if practi-



cable, a meeting of the board should be held annually to consider matters bearing on the maintenance of the supply of wild fowl and a perpetuation of wild fowl hunting throughout the country.

The Biological Survey continues to receive the friendly cooperation of a great number of State and local organizations and individuals, which adds immeasurably to the effectiveness of its work. It is fortunate that this is so, for without the good will of the State game and conservation commissioners and of organizations and individuals interested in bird conservation, efforts to administer the migratory-bird treaty act and to promote general conservation would be seriously hampered. The assistance of such organizations as the Boone and Crockett Club, the American Game Protective Association, and the National Association of Audubon Societies is invaluable in this work. For years the last-named organization has contributed annually considerable sums of money to aid the conservation work of the bureau; in the spring of 1920 it spent \$1,600 in the payment of warden service in Florida for the protection of egret colonies under the supervision of Federal wardens. Through the cooperation of these organizations and of State game commissioners and sportsmen, a healthful sentiment for game conservation has been created in many sections where formerly the people were not favorable to Federal protection of migratory birds.

#### INTERSTATE COMMERCE IN GAME.

Interstate commerce in wild animals and parts thereof is regulated by sections 242, 243, and 244 of the Penal Code, commonly referred to as the Lacey Act. Special efforts have been made to complete investigations of a large number of shipments uncovered during the last fiscal year, in addition to investigating current shipments which seemed to have greatly increased owing to the high prices of furs now prevailing.

Twenty-six violations have been reported to the solicitor of the department, involving shipments of 233 beaver, 4 otter, 125 deer-skins, 1,634 pounds of deerskins, a miscellaneous lot of moose and deer hides, 1 deer, 568 quail, and quantities of aigrettes.

During the year 22 convictions were secured, in which fines amounting to \$1,070 were imposed; 6 cases were dismissed because of insufficient evidence; 3 were stricken from the docket; and 1 case was terminated by death of defendant.

The completion of investigations of a large number of other shipments disclosed no violations of the Federal law, as they were not made by common carrier or else involved animals or parts thereof shipped in accordance with State laws. Many cases of shipments made in violation of State laws were turned over to appropriate State authorities for prosecution when it was thought the best results could thereby be obtained. Through this cooperation the States not only collected many thousands of dollars in fines and penalties, but were better enabled to keep in close contact with shippers and thus to discourage violations of the law. One hundred and thirty-one shipments are still under investigation.

Cases reported for prosecution originated in the following States: Colorado, 2; Idaho, 1; Illinois, 2; Iowa, 1; Minnesota, 2; Missouri,



1: New Hampshire, 1: New Mexico, 2: New York, 1: North Carolina, 1: Oregon, 7: Tennessee, 1: Utah, 1: Washington, 2: Wisconsin, 1.

At the request of the bureau many of the large fur dealers are republishing in their catalogues and advertising material information furnished by the department concerning State trapping and shipping laws and are omitting from their price lists quotations on furs of animals for which no open season is provided.

#### IMPORTATION OF BIRDS AND MAMMALS.

The number of permits issued during the year showed an increase of 66 per cent—from 273 in 1919 to 453 in 1920—and the number of inspections from 42 to 89. The permits issued for the entry of foxes from Canada showed a total of 805 as compared with 335 in 1919. At Honolulu permits were issued for the entry of a few birds, including pheasants and several miscellaneous cage birds. So far as known no prohibited species were entered during the year.

The resumption of importations of foreign birds from European ports has increased slowly. Shipments of canaries from Germany have begun, but only in small numbers and by no means sufficient to meet the holiday trade. A few Indian and African consignments have reached New York, some of them by way of England. At San Francisco shipments from the Orient, particularly from Australia, have shown a steady increase. Large numbers of Lady Gould finches, both black and red-faced, have been received, and also many rare and interesting birds, including two gray-headed geese (*Chloephaga poliocephala*) from southern South America, four African ducks (*Anas undulata*), four Cabot tragopans (*Tragopan caboti*) from southeastern China, two satin bower birds (*Ptilorhynchus violaceus*) from Australia, a green barbet (*Thereiceryx zeylanicus*) and eight white-eared hill tits (*Mesia argenteauris*) from India, a short-tailed parrot (*Graydidisculus brachyurus*) from Brazil, two gray-winged trumpeters (*Psophia crepitans*) from British Guiana, and a number of Siberian goldfinches and other species imported for exhibition purposes.

Shipments from South America have not increased as much as might have been expected, although some birds have been received from Colombia, Venezuela, and Brazil. The prevailing rates of exchange, which have been unfavorable in several South American countries, have had an important bearing in limiting shipments by importers who are accustomed to outfit traveling representatives in foreign countries.

#### IMPORTATION OF QUAIL FROM MEXICO.

The regulations governing the importation of quail from Mexico were modified under date of September 18, 1919, to provide an open season from November 15 to March 31, and a port of entry was established at Brownsville, Tex. Under date of March 15, 1920, the open season was extended 10 days, to April 10. Through the co-operation of the Bureau of Animal Industry arrangements for inspection and quarantine were provided at the three ports of Browns-

ville, Laredo, and Eagle Pass, Tex. The number of quail entered from Mexico was 24,337, but the number released from quarantine was 23,473. Quail disease appeared among the birds entered at Eagle Pass and Laredo. Entries were suspended at Eagle Pass for three weeks, and after March 9 no further importations were made. At Laredo no entries were received in quarantine during the investigation of the presence of the disease. At Laredo 253 birds died during the quarantine and 59 at Eagle Pass, but at the latter point 540 birds, many of them infected with quail disease, were returned to Mexico. On the whole, more quail were imported than for several years past, but in spite of the long season and the special facilities provided for entry and quarantine, the results were not altogether satisfactory. Several reports received by the department indicate that a number of the birds died after reaching destination, and in one case a large proportion of the birds ordered by one of the State commissions late in the season died within a few days after arrival.

Importations of quail from Mexico began about 1910, and during the 10 years that entries have been made the total number imported, including entries of the present year, was approximately 92,000, of which about 56,000 were brought in during the seasons of 1917 and 1920. The success of these importations as a whole is exceedingly doubtful and those contemplating future importations should study the outcome of previous importations to avoid as many detrimental factors as possible.

#### CONSERVATION OF MARSH AREAS.

For two years the Biological Survey has made a special effort to draw the attention of all sportsmen, including State game commissions, to the menace to the future of our migratory wild fowl through the drainage of small lakes and swampy areas on a constantly increasing scale. The appreciation of the situation is becoming general and it is hoped that effective steps may be possible whereby the Federal and State Governments may secure permanent title to a number of such areas to be maintained in perpetuity as bird preserves. The greater number of these preserves should be guarded as sanctuaries during the breeding season and be maintained as public hunting grounds for the benefit of all citizens during the open season. A small number should be held as sanctuaries throughout the year to serve as reservoirs to supply other areas with wild fowl. Before the drainage of such water areas is undertaken it would be desirable to have experts make a careful survey and report on the relative value of each area for agricultural purposes and, in its natural condition, as a producer of wild fowl, furs (muskrats, etc.), fish, and ice, and as a public recreation ground whereby out-of-door sports may be maintained and the health and well-being of the citizens promoted. Other important uses for lake and marsh areas in many places are the maintenance of the normal underground water level, affecting springs, wells, and vegetation, often at considerable distances, and the prevention of erosion by delaying the run-off of flood water.

**REINDEER INDUSTRY AND FUR BEARERS OF ALASKA.**

In the appropriation act approved May 31, 1920, for the fiscal year ending June 30, 1921, provision was made for the Biological Survey to investigate the reindeer industry in Alaska with a view to its development. At the same time the administration of the laws protecting the land fur-bearing animals of Alaska was transferred from the Bureau of Fisheries in the Department of Commerce to the Biological Survey. During June, 1920, the services of an experienced pathologist and veterinarian and two men experienced in grazing investigations in the Forest Service were obtained for the purpose of acquiring basic information needed for the furthering of the reindeer industry. An experiment station will be established as soon as possible after the beginning of the fiscal year 1921, at some point on the coast of Bering Sea. A naturalist will spend the year investigating the caribou herds of Alaska to obtain information which will be useful in this work. The enormous area occupied by the land fur-bearers of Alaska, which are being seriously over-trapped, renders their protection exceedingly difficult. However, a warden service will be established and so far as possible with the limited funds available the Alaskan fur-bearers will receive protection.



## REPORT OF THE CHIEF OF THE DIVISION OF ACCOUNTS AND DISBURSEMENTS.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
DIVISION OF ACCOUNTS AND DISBURSEMENTS,  
*Washington, D. C., October 1, 1920.*

SIR: I have the honor to submit herewith a report of the work of the Division of Accounts and Disbursements for the fiscal year ended June 30, 1920.

Respectfully,

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

A. ZAPPONE,  
*Chief of Division.*

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### CHARACTER OF WORK.

The chief of the division and disbursing clerk is charged by the Secretary of Agriculture with the duty of preparing all requisitions for the advance of public funds from the appropriations for the Department of Agriculture to the disbursing clerk and to special disbursing agents charged with the disbursement of public funds, the keeping of accounts and appropriations ledgers relating to the advance and disbursement of all items of appropriations, and the examination and payment of all vouchers and pay rolls submitted from the various offices, bureaus, and services of the department. He performs such other duties as may be prescribed by the Secretary.

### WORK OF THE YEAR.

#### APPROPRIATIONS, EXPENDITURES, ETC.

To carry on the work of the Department of Agriculture during the fiscal year ended June 30, 1920, Congress appropriated \$33,899,761 in the agricultural act for that fiscal year: in addition to which permanent annual appropriations, special appropriations, deficiency appropriations, and the appropriation for printing and binding were available, amounting to \$168,834,163, making a total of \$142,733,924, of which sum \$70,265,464.64 was expended, leaving a balance at the end of the fiscal year of \$72,468,459.36. This balance includes \$68,782,389.45 appropriated for the construction of rural post roads and which amount will be available until expended, so the net balance for the fiscal year 1920 is only \$3,686,069.91 and which is nearly all covered by outstanding liabilities.

Supplemental accounts for the year 1919 were also paid, amounting to \$890,986.28.

On June 30, 1920, the unexpended balances for the year 1918, amounting to \$5,196,292.76, were finally covered into the Treasury to the "Surplus fund."

There were received, examined, and paid by this office 176,096 vouchers and pay rolls, which required the issuance of 295,731 checks on the Treasurer of the United States.

There were also sent to the Treasury Department for payment 10,057 accounts.

## LOST CHECKS.

During the year 318 checks were lost in transit through the mails or by the payees, and were duplicated by this office.

## PUBLIC MONEYS RECEIVED FROM VARIOUS SOURCES.

There were received from various sources and deposited in the Treasury to the credit of the proper funds the following sums:

Telegrams over Government lines.....	\$6,050.79
Sale of cotton standards.....	11,203.05
Cost of cotton-futures disputes.....	204.00
Sale of loose cotton.....	22,926.21
Classification of cotton.....	41,702.68
Cost of grain standards appeals.....	15,312.90
Sale of grain.....	9,033.96
Cost of market-inspection food products.....	57,050.09
Cost of warehouse disputes.....	339.00
Sale of nitrate of soda to farmers.....	5,288,808.60
Sale of photo prints.....	788.18
Sale of lantern slides.....	1,044.65
Sale of hearings.....	109.05
Sale of card indexes.....	110.84
Sale of seeds.....	1,307.00
Sale of other miscellaneous Government property.....	241,633.42
Sale of agricultural products, Alaska.....	2,008.92
Sale of agricultural products, Hawaii.....	133.03
Sale of agricultural products, Porto Rico.....	1,976.36
Sale of agricultural products, Guam.....	49.50
Sale of agricultural products, Virgin Islands.....	2,366.45
Cooperative work, Forest Service.....	1,979,651.09
Forest Reserve fund.....	4,793,482.28
Refund on mileage books, etc.....	187,049.34
Transfers from other departments for work done and supplies furnished.....	301,146.76
Total.....	12,965,488.15

STATEMENT OF APPROPRIATIONS, DISBURSEMENTS, AND UNEXPENDED BALANCES  
FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE.

[Fiscal years 1839 to 1904, inclusive.]

Fiscal year.	Amount appropriated.	Amount disbursed.	Amount unexpended.	Fiscal year.	Amount appropriated.	Amount disbursed.	Amount unexpended.
1839..	\$1,000.00	\$1,000.00		1872..	\$197,070.00	\$195,977.25	\$1,092.75
1840..				1873..	202,440.00	201,321.22	1,118.78
1841..				1874..	257,690.00	233,765.78	23,924.22
1842..	1,000.00	1,000.00		1875..	337,380.00	321,079.83	16,300.17
1843..				1876..	249,120.00	198,843.64	50,276.36
1844..	2,000.00	2,000.00		1877..	194,656.96	188,206.19	6,450.77
1845..	2,000.00	2,000.00		1878..	198,640.00	197,634.94	1,005.06
1846..	3,000.00	3,000.00		1879..	206,400.00	206,360.00	40.00
1847..	3,000.00	3,000.00		1880..	199,500.00	198,361.72	1,138.28
1848..	4,500.00	4,500.00		1881..	275,460.31	267,608.84	7,851.47
1849..	3,500.00	3,500.00		1882..	363,011.05	354,482.39	8,528.66
1850..	5,500.00	5,500.00		1883..	456,396.11	438,941.72	17,454.39
1851..	5,500.00	5,500.00		1884..	416,641.10	413,618.09	3,023.04
1852..	5,000.00	5,000.00		1885..	655,930.25	558,934.89	96,995.36
1853..	5,000.00	5,000.00		1886..	677,973.22	519,196.11	158,777.11
1854..	10,000.00	10,000.00		1887..	657,641.81	628,287.14	29,354.67
1855..	50,000.00	50,000.00		1888..	1,027,219.06	1,011,282.62	15,936.44
1856..	30,000.00	30,000.00		1889..	1,134,480.60	1,033,590.22	100,890.38
1857..	75,000.00	75,000.00		1890..	1,170,139.11	971,823.62	198,315.49
1858..	63,500.00	63,157.25	\$342.75	1891..	1,372,049.21	1,266,277.36	105,771.85
1859..	60,000.00	60,000.00		1892..	2,303,655.75	2,253,262.29	50,393.46
1860..	40,000.00	40,000.00		1893..	2,540,060.72	2,355,430.25	184,630.47
1861..	60,000.00	60,000.00		1894..	2,603,855.58	1,977,469.28	626,386.30
1862..	64,000.00	63,704.21	295.79	1895..	2,506,915.30	2,021,030.38	485,884.92
1863..	80,000.00	80,000.00		1896..	2,584,013.22	2,094,916.42	489,096.80
1864..	199,770.00	189,270.00	10,500.00	1897..	2,448,763.53	2,348,512.98	100,250.55
1865..	112,304.05	112,196.55	107.50	1898..	2,467,902.00	2,425,510.44	42,391.56
1866..	167,787.82	167,787.82		1899..	2,829,702.00	2,827,795.65	28,906.27
1867..	199,100.00	199,100.00		1900..	3,006,022.00	2,947,603.42	58,418.58
1868..	279,920.00	277,094.34	1,925.66	1901..	3,304,265.97	3,239,137.39	65,128.58
1869..	172,593.00	172,593.00		1902..	3,922,780.51	3,902,675.79	20,104.72
1870..	156,440.00	151,596.93	4,843.07	1903..	5,015,846.00	4,734,230.84	281,615.16
1871..	188,180.00	186,876.81	1,303.19	1904..	5,025,024.01	4,969,311.64	55,712.37

## STATEMENT OF APPROPRIATIONS, DISBURSEMENTS, AND UNEXPENDED BALANCES FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE.

[Fiscal years 1905 to 1920, inclusive.]

Fiscal year.	Agricultural appropriation act.			Other acts.			Total.		
	Appropriated.	Disbursed.	Unexpended.	Permanent annual appropriations, deficiency acts, special acts and printing and binding under the sundry civil act.	Disbursed.	Unexpended.	Appropriated.	Disbursed.	Unexpended.
1905.....	\$5,902,040.00	\$5,826,365.63	\$75,674.37	\$1,207,642.62	\$1,207,642.62	.....	\$7,109,682.62	\$7,034,008.25	\$75,674.37
1906.....	6,882,690.00	6,086,510.02	196,179.98	1,955,219.96	1,955,219.96	.....	8,837,909.96	8,641,729.98	196,179.98
1907.....	9,932,940.00	9,508,845.02	364,094.98	3,146,583.98	2,310,491.66	.....	13,079,523.98	11,879,336.68	1,200,187.30
1908.....	9,447,290.00	9,279,955.36	167,334.64	3,590,512.62	3,315,546.89	.....	274,965.79	12,585,502.25	442,300.37
1909.....	11,672,106.00	11,478,066.40	193,439.60	4,481,428.74	4,368,528.79	.....	16,153,534.74	15,847,195.19	306,339.55
1910.....	12,995,036.00	12,647,918.27	347,117.73	4,120,374.35	4,056,552.21	.....	17,115,410.35	16,704,470.48	410,939.87
1911.....	13,487,636.00	13,184,652.22	302,983.78	7,400,813.28	7,240,115.70	.....	20,888,449.28	20,424,767.92	463,681.36
1912.....	16,900,016.00	15,530,970.55	1,369,045.45	5,503,193.00	5,455,236.73	.....	22,403,209.00	20,986,207.28	1,417,001.72
1913.....	16,651,496.00	15,065,448.40	646,047.60	6,010,819.00	5,966,478.82	.....	22,662,315.00	21,971,927.22	690,387.78
1914.....	17,980,945.00	17,297,761.46	689,183.54	6,100,000.00	6,030,353.57	.....	24,086,945.00	23,328,115.03	758,829.97
1915.....	19,865,832.00	19,408,375.18	457,456.82	9,014,243.00	8,677,297.44	.....	28,880,075.00	28,085,672.62	794,402.38
1916.....	22,971,782.00	20,388,732.08	2,583,049.92	5,032,300.00	4,915,804.19	.....	28,004,082.00	27,000,520.03	2,699,545.13
1917.....	24,948,832.00	21,093,357.38	3,855,474.62	11,184,248.00	5,368,162.65	.....	36,133,100.00	32,557,453.70	9,132,579.97
1918.....	25,929,113.00	16,903,351.07	9,019,761.93	45,201,400.00	15,648,102.65	.....	71,130,513.00	67,884,607.54	38,573,059.30
1919.....	27,875,353.00	25,764,662.45	2,110,690.55	86,211,863.00	18,327,255.40	.....	114,087,216.00	114,087,216.00	69,995,298.00
1920.....	33,899,761.00	30,226,626.16	3,673,124.84	108,834,163.00	40,038,828.48	.....	112,733,924.00	70,265,464.64	72,468,459.36





## REPORT OF THE CHIEF OF THE DIVISION OF PUBLICATIONS.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
DIVISION OF PUBLICATIONS,  
*Washington, D. C., August 25, 1920.*

SIR: I have the honor to submit herewith a report on the work of the Division of Publications for the fiscal year ended June 30, 1920.

Respectfully,

EDWY B. REID,  
*Chief of Division.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### ALL INFORMATIONAL WORK OF THE DEPARTMENT PLACED UNDER THE DIVISION OF PUBLICATIONS.

An order of the Secretary issued during the year placed the Office of Information, the Office of Exhibits, and the motion-picture work under the direction of the Chief of the Division of Publications. This action was taken with a view to bring all informational work of the department under one head.

As thus reorganized the work of the division is grouped under the following branches: (1) Information; (2) agricultural exhibits; (3) motion pictures; (4) editing, printing, and indexing; (5) illustrating; (6) distributing; (7) addressing and duplicating.

The centralization of all mailing lists of the department in this division is another step which has been recommended. A careful investigation has been made of the duplicating work and a plan is under consideration by which all machinery, equipment, materials, and personnel now employed in the various offices of the department may ultimately be centralized in this division so far as practicable. From the study so far made it is believed that the combined plant proposed for all duplicating and mailing work will effect a substantial saving and, in addition, the output will have the benefit of careful supervision.

### OUTPUT OF THE YEAR.

The number of new publications issued during the year was 589, of which 61 were Farmers' Bulletins. Publications distributed aggregated 45,237,747 copies; of this number 13,122,129 were Farmers' Bulletins. This includes the distribution, through the Division of Publications, of the congressional quotas of Farmers' Bulletins, in

connection with which more than 6,800,000 Lists of Farmers' Bulletins also were distributed to facilitate intelligent selection of bulletins needed. More than 500,000 copies of Farmers' Bulletins were assigned to the department by Members of Congress from their individual allotments.

### THE APPROPRIATION FOR PRINTING AND BINDING.

The regular appropriation for printing and binding for the year was the same as for the preceding year, namely, \$600,000. On account of the large carry-over of uncompleted work from the preceding year (costing \$53,607.38), the greater cost of printing, and the increasing requirements of the department for printing and binding, the appropriation was exhausted in April, and the printing of the department's publications was suspended practically for a period of more than a month. In May Congress granted a deficiency appropriation of \$75,000. This amount was sufficient to print only a portion of the accumulated material which was still suitable for distribution. Some bulletins had to be rejected because of insufficient funds to print them at the season when they would have been useful. Other bulletins could not be undertaken or completed because the deficiency appropriation became available too late for the Government Printing Office to do the work, in consequence of which \$10,506.40 of the deficiency appropriation remained unexpended at the close of the year.

The appropriation for printing and binding for the fiscal year which ends June 30, 1921, is \$725,000, which is but a fraction over 2 per cent of the appropriation for the activities of the department. An appropriation of \$1,000,000 for printing and binding would more nearly meet the requirements of the department in the dissemination of the useful information it is constantly acquiring for the benefit of the people. A private business concern spending \$31,000,000 annually in the production of something of value to the people would spend double the amount allowed the department to furnish its service to the public.

### PRINTING DONE OUTSIDE THE GOVERNMENT PRINTING OFFICE.

Under the provisions of section 11 of public act 314, approved March 1, 1919, the executive departments were estopped from procuring printing or binding outside the Government Printing Office except by permission of the Joint Committee on Printing. That committee, by Regulations No. 4, granted authority to the Department of Agriculture to order outside printing of an emergency character not to exceed \$5,000 in the aggregate, to be defrayed from the appropriations of the bureaus for which the printing was ordered. In addition to this, specific permission was granted to secure tags, certificates, etc., for the Bureau of Animal Industry for use in the enforcement of the meat-inspection law, the aggregate expense of which was \$29,052.50. These supplies had been contracted for prior to the beginning of the year, and the committee authorized completion of the work.

Special authority was obtained for printing a booklet, "The Live-Stock Industry of the United States," for distribution in South America. Other authorized outside printing for the fiscal year



brought the total to \$40,535.74, all of which was approved, contracted for, supervised, and procured by this division during the year. A detailed report of this work was submitted to the committee as required by law.

The Joint Committee also gave general authority for printing, binding, and blank-book work outside of the Government Printing Office for the exclusive use of the following field services of the department:

For any Government service in Alaska, Guam, Hawaii, the Panama Canal, the Philippines, the Virgin Islands, or any other place outside territorial United States: *Provided*, That the work is done in the Territory, possession, or country where the service is located. (Regulations No. 3.)

For field use of the Forest Service, to be done at its supply-depot printing plant. (Regulations No. 3.)

For such printing and binding as may be required to issue local weather maps, forecast cards, and local bulletins by the field stations of the Weather Bureau. (Regulations No. 4.)

Under the first regulation quoted, printing for the experiment stations of the States Relations Service in the territorial possessions enumerated may be done there and, under decision of the comptroller, may be paid from the appropriations for those stations.

Detailed reports of all outside printing authorized by the joint committee are required to be submitted quarterly. These reports for the quarters ending October 1, January 1, April 1, and July 1 were prepared and submitted.

#### PUBLICATION OF SCIENTIFIC AND TECHNICAL PAPERS IN OUTSIDE PUBLICATIONS.

In order to place the preliminary results of its investigations in the hands of interested specialists and others as quickly as possible, the department encourages its scientific and technical workers to publish in professional journals brief papers reporting special phases of the results of their work. During the year 739 such papers, averaging 2 to 3 each day, or about 60 per month, were approved for publication in outside journals. They were contributed by workers in various bureaus, as follows:

##### *Papers approved for publication in outside journals.*

Bureau, division, or office.	Number of articles.
Animal Industry .....	65
Biological Survey .....	72
Chemistry .....	146
Crop Estimates .....	1
Entomology .....	76
Farm Management .....	3
Federal Horticultural Board .....	2
Forest Service .....	139
Markets .....	18
Plant Industry .....	158
Publications .....	3
Public Roads .....	16
Bureau of Soils .....	16
States Relations Service .....	10
Solicitor .....	1
Weather Bureau .....	13
Total .....	739

This method of publication secures prompt announcement of the department's investigations, which is particularly important in the scientific world, and saves the department's printing fund for more elaborate and final reports and for the increasing number of practical and popular bulletins.

The manuscripts of these papers are reviewed in this division and records are kept showing when and in what publications the papers are used.

#### CONGRESSIONAL RESTRICTION ON PERIODICALS AND FIELD PRINTING.

By section 11 of an act of Congress approved March 1, 1919, authority was given the Joint Committee on Printing to employ such measures as it might deem necessary to remedy any neglect, delay, duplication, or waste in the public printing and binding and the distribution of Government publications. That section also provided that thereafter no periodical should be printed and issued unless specifically authorized by Congress, but that such periodicals as were then being printed without specific authority from Congress might, "in the discretion of the Joint Committee on Printing," be continued until the close of the next regular session of Congress, when, if authority for their continuance had not then been granted by Congress, they should not thereafter be printed.

Acting under this provision, the Joint Committee issued "Regulations No. 1," in which it was announced that the Public Printer had been instructed not to print any periodical after May 1, 1919, unless specifically authorized by Congress, or unless the Joint Committee had authorized its continuance until the close of the following regular session of Congress. The statement was added that this instruction also applied to publications printed at Government expense elsewhere than at the Government Printing Office. Copies of this communication were addressed to this department, and presumably to all other executive branches of the Government.

Regulations No. 1 also requested that full information be given the Joint Committee regarding periodicals then being issued, together with reasons and recommendations for their continuance until the close of the next regular session of Congress. This information was furnished the Joint Committee regarding each of the periodicals and similar publications then being issued by the department, and representatives of the department appeared before the committee to explain their necessity.

By Regulations No. 3 the Joint Committee authorized the continuance of existing periodicals until August 1, 1919, and by Regulations No. 4 until October 1, 1919.

By Regulations No. 5, issued September 19, 1919, the Joint Committee authorized the continuance of journals, magazines, and periodicals existing on July 1, 1919, until otherwise disposed of as provided for in the act referred to. The committee withheld approval or disapproval at that time, with the statement that its recommendations would later be submitted to Congress. Certain exceptions were made to this general authorization, the only one affecting this department being the authority to combine the Seed Reporter and the Food Surveys in one periodical to be known as the Market Reporter.

By section 4 of the act providing for the sundry civil expenses of the Government for the year ending June 30, 1921, Congress authorized the continuance until that date of any journal, magazine, periodical, or similar publication which is now being issued, "when, if it shall not have been specifically authorized by Congress before that date, such journal, magazine, periodical, or similar publication shall be discontinued."

Thus, although this department responded in full detail to the request of the Joint Committee on Printing for information regarding all its periodicals and similar publications, explaining the reasons why they were necessary in the public interest, and although the department submitted a provision to be inserted in the sundry civil bill which would have authorized them, we are still confronted with the necessity of appealing to Congress for specific authority for the publication of each individual periodical.

Some of the periodicals of this department have been issued for many years, and have become indispensable. Others of more recent institution have become equally necessary to the proper performance of the department's duty to "acquire and to diffuse" useful information on agricultural subjects. The Monthly Crop Reporter, the Weekly News Letter, the Experiment Station Record, the Market Reporter, and the Journal of Agricultural Research are instances of such essential periodicals, not to mention others, which contain material which must be published in some form, and no more economical form than the periodical can be found.

It is submitted that the general authority to print, which this department now has under the organic act creating it and under the printing law of 1895, should be extended to include definite authority to issue periodicals, leaving to this department, not to Congress or any committee of Congress, the decision as to what periodicals to issue. For Congress to specify what periodicals may be issued is to exercise executive functions. Still more are executive functions being performed when the decision is left to a committee of Congress. If discretion regarding executive acts is to be lodged anywhere, it should be lodged in the executive branch of the Government.

It should be noted in this connection that the Joint Committee on Printing, under the provisions of section 11 of the act quoted, is still exercising authority over the field printing of the department, deciding in individual cases what may be printed elsewhere than at the Government Printing Office and what may not. This procedure is open to the same objection as has just been made to their control over periodicals.

In the interest of efficient administration of this department, section 11 of the act of March 1, 1919, should be repealed, and this department should be left to decide for itself what and how to print, subject only to the orderly inquiry which Congress has always made in considering annually the amount which it will appropriate for the printing and binding.

#### CONTACTS WITH THE PRESS.

The Office of Information, the channel through which the department's information reaches the press, in the last year has served more classes of publications with a greater variety of press material in a larger quantity than in any year since it was organized.



While quantity production is not in itself a true measure of effectiveness or success, it indicates the broadening field of the department's informational activities and an enlargement of its service.

In developing the special service to noncompeting publications, the office has not only increased the amount of material furnished to agricultural journals, but has also extended it to include Sunday newspapers, trade publications, and periodicals using popular science material. It has compiled data for addresses and special articles by the Secretary of Agriculture bearing on the work of the department and has made them available and secured their publication in the interest of agriculture. Increasing use has been made of photographic material in the rotogravure sections of Sunday newspapers and in "picture pages" for the agricultural press. As a result of these activities in new directions, unquestionably a wider use has been made of information about the department's activities during the year than ever before.

The efforts of the Office of Information during the year have been directed toward the following informational services:

#### WEEKLY NEWS LETTER.

This journal is both a news service and a house organ. As a news service it carries official statements by the Secretary and by the various bureaus of the department, and stories reporting the progress of the department's investigations. As a house organ for the department's large staff of employees and official cooperators, it strives to keep them informed of new work begun and the progress of various campaigns, and to present ideas that will help them in their work. The Weekly News Letter prints only such matter as is of wide interest. While most of the items are prepared in a form suitable for publication, the chief value of certain articles to editors is to present the department's views on various subjects and to provide information for such use as the editors desire to make of it.

The Weekly News Letter is sent free only to employees, official cooperators, and the press. It may be obtained by anyone, however, at the subscription rate of 50 cents a year. Because of limited funds for printing and increasing costs of mechanical work and materials, the circulation of this journal was reduced by 9,000 during the year—from 142,000 to 133,000. The size of many issues was limited to eight pages for the same reason, thereby preventing the use of much valuable material.

As the department's official organ, the Weekly News Letter should be more liberally supported. With adequate funds for its publication it could be much improved in contents, size, and appearance. It should be more representative of the big organization for which it makes contact with the public and the press.

#### SPECIAL INFORMATION SERVICE.

This is an illustrated weekly syndicate sheet of eight columns, for daily newspapers. It is issued several days in advance of its release. The articles in it are carried under four departments of two columns each, as follows: "Growing Food—on the Farm, in the Yard"; "Agriculture's Other Half—Marketing"; "A Bird in the

Hand" (poultry): "The Housewife and Her Business." This service has been furnished to 2,575 daily and weekly newspapers that have asked to receive it. While it is primarily a daily newspaper service, it is sent also to agricultural journals that request it.

The need for developing informational services that would carry the department's message to city people brought about the establishment of the Special Information Service. It has met a popular demand for stories on how to produce food in backyards and how to preserve food and use it most economically in the home. While it was begun during the war as a service for city readers, it has been developed to apply and appeal to people in town and country. Telling stories of food production, both on the farm and in backyards, of marketing problems as they relate to the consumer as well as to the producer, and of household economy on the farm as well as in town has broadened its field of usefulness and has enabled it to serve another purpose—to interest and inform city people of agricultural problems, thereby inspiring a greater respect for the important place of food in our national activities and a better understanding of its production and distribution.

#### FOOD AND FARMING WEEKLY.

In this service, a press clipping sheet released every Monday, we seek to give the press a running account, week by week, of what the Department of Agriculture is doing. It consists of 8 to 12 short stories, of 200 to 300 words each, about departmental investigations and research. This service attempts to meet the requirements of editors for brevity by telling its stories in the fewest words possible. It is sent to 5,200 publications of all classes that have requested it.

#### HOME GARDEN AND CANNING-DRYING SERIES.

To stimulate home gardening and home preservation of foods, seasonable articles on these subjects are issued to newspapers. They include "how-to-do-it" items and stories of successful experiences that contain helpful ideas. Until the year just closed cuts, mats, and photographic prints of the illustrations used in the service were furnished the newspapers, and the articles were grouped on printed proof sheets in attractive suggestive layouts with illustrations. Insufficient printing funds prevented the use of illustrations in these services during the year, and they were issued in mimeographed form. Four hundred daily newspapers asked for the material. The year before, when cuts, mats, and photographs were lent, 1,241 newspapers requested the articles. The contrast in these figures indicates how illustrations add to the attractiveness of this material, although the shortage of newsprint paper probably was a factor in the reduced circulation.

#### PLATE SERVICE.

One of the ways in which contact is made with the weekly and small daily newspapers in the country is through the plate and ready-print service of a large news agency. Twenty to twenty-five columns of matter with illustrations are furnished to this concern weekly. In addition to this specially prepared material, proofs and illustrations of the Special Information Service are furnished, and this matter is

also distributed in plate and ready-print. The plate service enables the department to reach with its informational material millions of readers of small newspapers which are unable to set the type in their own offices. In 1918—the 1919 figures are not yet available—more than 62,000 columns of this material, nearly all of it furnished by this department, were used by the newspapers. Our part in this form of distribution is only in furnishing the material. The plate and ready-print matter is sold by the news agency at a moderate price.

#### MIMEOGRAPH SERVICE.

News matter requiring immediate distribution is issued in mimeograph and sent generally or locally, according to its applicability and interest. By this means the Office of Information supplies “spot” news to press associations, Washington correspondents, agricultural journals, trade journals, and newspapers.

#### NONCOMPETING SERVICE.

Attention has been given during the year to extending this service and making it more effective. The preparation of articles for distribution to noncompeting publications was initiated two years ago to meet the demand for special stories and to enable the department to present more thoroughly and completely the results of its more important lines of work. The service has proved to be very popular with editors, and from the department's standpoint it is one of the most effective ways of reaching the public with detailed, authoritative stories of its achievements. For the agricultural press a number of noncompeting lists of journals have been made up from correspondence with editors, and the lists are used in rotation to give equal opportunity to each group of publications. The obvious advantage of noncompeting distribution is that each publication, having the story exclusively in its own territory, will gladly feature it prominently. And since each list covers the entire country, wide distribution is assured every article. The noncompeting lists also have been used successfully for placing photographic layouts, picture pages, and cartoons. The service has been extended to include trade journals, popular science magazines, and Sunday newspapers.

#### SPECIAL ARTICLES AND STATEMENTS.

The Office of Information prepares a great many articles, most of them on request, for the exclusive use of certain publications. It also acts as a medium for securing such articles from department specialists and other officials on the request of editors. Special articles by writers in the office have been accepted by leading periodicals in greater number during the year.

#### POSTERS AND CIRCULARS.

The preparation of posters and circulars for use in support of the various educational campaigns carried on by the department is another feature of the informational work. The pulling power of posters was conclusively demonstrated to the department during the war. In the last two years the Office of Information has made ef-



fective use of 30 posters portraying the various activities of the department and "selling" its service to the public. Assistance has been given a number of the bureaus in the preparation of illustrated circulars.

#### DISTRIBUTION OF PRESS MATERIAL.

Every effort is made to give the wisest possible distribution to our press material, so as to place it only where it will be of interest and to avoid waste. The mailing lists have been so specialized that it is possible to distribute material locally or generally or to publications even in different classes which have a common interest in a subject. To place an agricultural story strictly within the region of its applicability is sometimes extremely difficult, and in such cases editors are given the benefit of the doubt, as it seems better to include them in the distribution of a story rather than to miss them altogether, especially since editors many times are likely to be interested in the problems of their neighbors.

The work of the Office of Information was directed by Harlan Smith, assistant in charge.

#### PROGRESS IN MOTION PICTURES.

Marked advances made in the fiscal year 1920 in the production and distribution of the department's motion pictures leave no doubt as to the effectiveness and value of this mode of bringing directly to the people the knowledge developed by the department's investigations and of acquainting the public with the methods and significance of important lines of work being carried on by the department.

These forward steps may be described as follows:

Editorial and laboratory work was completed on 52 new motion-picture subjects, and they were added to the department's film library. The largest previous number of releases in a single fiscal year was 18, in the fiscal year 1919. A list of the new subjects follows:

	Reels.
American Roquefort Cheese.....	1
Health for Hogs.....	1
Making the South Tick-Free.....	1
Milk-Made Products.....	2
Selecting a Laying Hen.....	1
A Year with the Flock.....	1
Wool and Lamb Marketing.....	1
Preparing Mutton for Home Use.....	1
Swiss Cheese Made in America.....	1
"Leak" Disease of Potatoes.....	1
To Market—To Market.....	1
Wheat—Sack Handling.....	1
Wheat—Bulk Handling.....	1
Wheat—Transportation and Storage.....	1
Dust Explosions in Mills and Elevators.....	2
Explosive Dust.....	1
Most Wonderful Insect in the World—17-Year Locust.....	1
Screw Worms and How to Fight Them.....	1
The Horn Fly.....	1
The Stable Fly.....	1
Help Wanted to Feed the Nation.....	1
Cotton's Worst Enemy—Pink Bollworm.....	1
A Sportsman's Paradise.....	1

*New subjects completed and released during fiscal year 1920—Continued.*

	Reels.
Little Journeys in the National Forests.....	1
Outdoor Life in the Rockies.....	1
Wonderland of Canyons and Peaks.....	1
Pack Train Trip.....	1
Old Santa Fe—the Gateway to the Santa Fe National Forest.....	1
De Vargas Day in Santa Fe.....	1
The Prehistoric Bandelier.....	1
Summer Camps for Cities.....	$\frac{1}{2}$
The Santa Fe National Forest.....	2
When Cowboys Get Together.....	1
Sentinels of the Sunset.....	$\frac{1}{2}$
Summer Fun on the Western National Forests.....	1
Summer Home on the Sierra National Forest.....	1
The Fiery Lance.....	1
Trails That Lure.....	1
The Work of the Forests Products Laboratory.....	2
Winged Guardians of the Forest.....	1
How and Why of Spuds.....	1
Story of White Pine.....	1
White Pine—A Paying Crop for Idle Lands.....	1
White Pine—The Wood of Woods.....	1
Logging Eastern White Pine.....	1
Nature's Crop of White Pine.....	1
American Home Canning in France.....	1
Apples and the County Agent.....	3
Club Champions at Camp Vail.....	2
Cured by Canning.....	1
Fresh Fish—Can it.....	$\frac{1}{2}$
The Home Demonstration Agent.....	3

Two hundred and ninety-seven reels of positive prints were added to the stock available for distribution.

Photographic, laboratory, or editorial work was begun on 23 new subjects, and progress was made toward completion of 12 left-over projects, either not yet released or not wholly completed.

Department Circular 114, "Motion Pictures of the U. S. Department of Agriculture," was issued, giving the first compact and complete summary of information needed by department field workers using motion pictures, and containing a complete list of films released up to the end of the fiscal year.

A survey of the motion-picture field in the State agricultural extension organizations was completed. This survey indicates an almost unanimous desire to use motion pictures in agricultural extension work, and leaves no doubt that the motion picture will be a really powerful aid in this field as soon as extension workers can more generally obtain projection machines, and as soon as the available subjects and positive prints can be made more nearly equal to the demand.

Arrangements were completed by which persons and institutions not directly connected with the Department of Agriculture may purchase, under certain restrictions, positive prints of the department's motion pictures. This arrangement, without cost to the department, already has resulted in a substantial increase in the distribution of the department's films. Purchasers of copies of department films now include State agricultural colleges and other State institutions, farmers' organizations, foreign Governments, commercial distributing agencies, and welfare organizations.

Needed equipment was added to the motion-picture laboratory, with an increase in quantity and an improvement in quality of output. The laboratory is now in a better position to keep step with photography in the field.

At the end of the fiscal year the department's motion-picture films included 112 agricultural subjects. The number of reels available for distribution was 460, or more than 460,000 feet of film. All of this film was in circulation, most of it constantly. During the year more than 700,000 persons witnessed showings of one or more department films. This calculation is based only on reports to the department from users of film, and takes no account of showings for which no reports were made.

These reports also indicate a wide variety of uses for the motion picture, despite its comparative newness in agricultural extension and field work. For instance, a county agent projects the film, "Construction of a Wooden Hoop Silo," before a farm bureau meeting, and he shows in 15 minutes what would require a full day to demonstrate. A Bureau of Animal Industry inspector overcomes opposition to cattle-tick eradication by showing "The Charge of the Tick Brigade," supplementing that film with "Making the South Tick-Free"; and enlists effective cooperation in hog-cholera eradication by use of the film, "Control of Hog Cholera." These instances may be multiplied to a number and variety governed only by local needs and conditions and by the enterprise of the field workers in taking advantage of the films that have been made primarily for their use.

Don Carlos Ellis, who since early in 1918 had been assistant in charge of motion-picture activities, resigned on January 1, 1920, to enter the commercial motion-picture business. On March 15, Fred W. Perkins was appointed to succeed him.

#### EXHIBITS AT AGRICULTURAL FAIRS.

The agricultural exhibits shown by the department at fairs and expositions are becoming more popular each year. Great effort has been put forth to make them fully representative of the department's work and also of the best practices in present-day agriculture. The chief purpose of the exhibits is educational—to influence the beholder to improve his own practice. During the fiscal year the exhibits were shown at 62 fairs, in 36 States, with an attendance of more than 8,000,000 persons. These facts indicate the value of this method of acquainting the public with the department's results.

Prior to the passage of the Agricultural appropriation bill for 1920, on July 24, 1919, only tentative plans for the work during the 1919 fair season could be made. Those fairs desiring the exhibits were determined, and all conditions surrounding each case were ascertained; the itineraries for each circuit were laid out, and arrangements made with the railroads for the prompt movement of the cars containing the exhibits. The exhibits were assembled at Alexandria, Va., divided into five nearly equal sets, each set when boxed and crated weighing about 20,000 pounds, and all made ready for shipment over the five circuits contemplated. The exhibits were contributed by 12 bureaus of the department and illustrated the work being done or results accomplished.



Two hundred and thirty panels, 42 folding cabinets, and 95 tables were used for displaying the exhibits. A list of subjects furnished by one bureau only follows.

*Sample list of exhibits—Forest Service.*

On panels: Photographs, charts, diagrams, etc. Land erosion through deforestation, Woodland improvement, Forest fires—effects, Forest-fire prevention, Destructive lumbering, Recreation in national forest, Farm-timber treating, Windbreaks, Methods of turpentine, Fence-post treating.

In models: Lumbering in New Hampshire, National forest—typical features, Erosion—result of deforestation, Box testing, Post treating, Forest fires, Wood waste and utilization, Windbreaks, Timber sales, Grazing lands, Southern Appalachian lumbering, Turpentine, Fence-post setting.

The itineraries covered by the five circuits included 39 fairs distributed over 27 States, as follows:

Circuit No. 1 extended as far west as Salem, Oreg., and included the States of Washington, Montana, Utah, and Arizona. Circuit No. 2 covered the States of Illinois, Kansas, Oklahoma, and Texas. Circuit No. 3 took in Ohio, New York, New Jersey, Louisiana, and Florida. Circuit No. 4 visited Minnesota and Wisconsin in the North, and Mississippi, Alabama, Tennessee, and Georgia in the South. Circuit No. 5 covered the States of Massachusetts, Virginia, North Carolina, and South Carolina.

The various bureaus contributed the services of about 100 representatives from time to time as they were needed for demonstration purposes at the various fairs. The traveling expenses and subsistence of these attendants were paid from the agricultural exhibits appropriation.

**EXHIBIT AT NATIONAL DAIRY SHOW.**

In addition to the exhibitions made at the State fairs included in the five circuits above noted a number of special shows were made, the most extensive being the exhibit and demonstration at the National Dairy Show, which was held in Chicago, Ill., October 6-12, 1919. This occupied 11,000 square feet of floor space and about 5,000 square feet of space around the walls. Nearly all the material shown was prepared especially for this show and originated in the Bureaus of Animal Industry, Plant Industry, and Markets, the Dairy Division taking the lead in supplying exhibits. During the six days of the show more than 150,000 persons visited the department's space and saw the exhibits.

**EXHIBIT AT INTERNATIONAL HAY AND GRAIN SHOW.**

A less extensive but no less interesting and instructive exhibit was made at the International Hay and Grain Show, which was held in conjunction with the International Live Stock Show at Chicago, Ill., November 29 to December 6, 1919. This exhibit covered a floor area of about 4,000 square feet and was made up of exhibits from the Bureaus of Plant Industry, Entomology, Markets, and Chemistry. Ten employees from these bureaus were detailed to assist the Office of Exhibits in installing and demonstrating these exhibits. The estimated attendance at this show was 250,000.

## MISCELLANEOUS EXHIBITS.

Other general exhibits were made at the Wyoming State Fair, held at Douglas, Wyo.; at the International Farm Congress, held at Kansas City, Mo.; and the Evansville Centennial Exposition, held at Evansville, Ind.

Special Forestry exhibits were made at Missoula, Mont.; Portland, Oreg.; Pueblo, Colo.; Riverside, Calif.; and Sacramento, Calif. Special exhibits of limited extent were made at Tyler, Tex., and at Pittsburg, Tex., Forestry and Plant Industry taking leading parts. A special exhibit by the Bureau of Markets in grain demonstration was held at Lincoln, Nebr., in connection with the State fair.

The Bureau of Public Roads made a special exhibit at the United States Good Roads Association meeting, held at Hot Springs, Ark., April 12-17, 1920. Special exhibits from the Poultry Division of the Bureau of Animal Industry were made at the Madison Square Garden, New York; Boston, Mass.; Baltimore, Md.; and Hartford, Conn., in connection with State or national poultry shows held at these points.

There were a few other minor exhibits, making a total of 62 for the year. The estimated attendance at all the shows in which the department participated is over 8,000,000.

## FAIRS AND EXPOSITIONS AT WHICH DEPARTMENT'S AGRICULTURAL EXHIBITS WERE SHOWN.

Below is a list of the fairs and expositions at which the agricultural exhibits prepared by the department were shown during the fiscal year of 1920:

South Georgia Fair, Albany, Ga., Oct. 20-25.  
Southeastern Fair Association, Atlanta, Ga., Oct. 13-18.  
Southern Exposition Fair Association, Augusta, Ga., Nov. 11-22.  
Alabama State Fair, Birmingham, Ala., Oct. 6-11.  
Idaho State Fair (Forestry Exhibit), Boise, Idaho, Sept. 22-29.  
Brockton Fair and Horse Show, Brockton, Mass., Sept. 30-Oct. 3.  
Midland Empire Fair (Special), Billings, Mont., Sept. 16-19.  
All-American Exposition, Chicago, Ill., Aug. 30-Sept. 15.  
National Dairy Show, Chicago, Ill., Oct. 6-12.  
International Live Stock Show, Chicago, Ill., Nov. 22-Dec. 6.  
State Agricultural and Mechanical Association, Columbia, S. C., Oct. 27-31.  
Ohio State Fair, Columbus, Ohio, Aug. 25-29.  
State Fair of Texas, Dallas, Tex., Oct. 6-19.  
Illinois-Indiana Fair, Danville, Ill., Aug. 24-30.  
Iowa State Fair, Des Moines, Iowa, Aug. 20-29.  
Wyoming State Fair (Special), Douglas, Wyo., Sept. 8-13.  
Albamarle Agricultural Association, Elizabeth City, N. C., Nov. 11-15.  
Evansville Centennial Exposition (Special), Evansville, Ind., Aug. 15-Sept. 1.  
Carolina Fair, Greenville, S. C., Sept. 1-6.  
Minnesota State Fair, Hamline, Minn., Aug. 30-Sept. 6.  
Montana State Fair, Helena, Mont., Sept. 8-13.  
Indiana State Fair, Indianapolis, Ind., Sept. 1-6.  
Florida State Fair and Exposition, Jacksonville, Fla., Nov. 15-30.  
International Farm Congress, Kansas City, Mo., Sept. 24-Oct. 3.  
Nebraska State Fair (Grain Demonstrations), Lincoln, Nebr., Aug. 31-Sept. 5.  
Georgia State Fair, Macon, Ga., Oct. 22-31.  
Memphis Tri-State Fair, Memphis, Tenn., Sept. 22-27.  
Mississippi-Alabama Fair, Meridian, Miss., Sept. 29-Oct. 4.  
Wisconsin State Fair, Milwaukee, Wis., Sept. 7-14.  
Western Montana Fair (Forestry Exhibit), Missoula, Mont.  
Oklahoma Free State Fair, Muskogee, Okla., Sept. 29-Oct. 4.  
Oklahoma State Fair and Exposition, Oklahoma City, Okla., Sept. 20-27.

- Arizona State Fair, Phoenix, Ariz., Nov. 3-8.  
 Southside (Va.) Industrial and Agricultural Exhibition, Petersburg, Va., Oct. 14-18.  
 Northeast Texas Fair (Special), Pittsburg, Tex., Oct. 21-Nov. 1.  
 Pacific International Live Stock Exposition (Forestry Exhibit and Special), Portland, Oreg., Nov. 17-22.  
 Colorado State Fair (Forestry Exhibit), Pueblo, Colo., Sept. 22-27.  
 North Carolina State Fair, Raleigh, N. C., Oct. 20-28.  
 Virginia State Fair, Richmond, Va., Oct. 6-10.  
 Southern California Fair (Forestry Exhibit), Riverside, Calif., Oct. 7-11.  
 Rochester Exposition, Rochester, N. Y., Sept. 1-6.  
 California State Fair (Forestry Exhibit), Sacramento, Calif., Aug. 30-Sept. 9.  
 Oregon State Fair, Salem, Oreg., Sept. 22-27.  
 Utah State Fair, Salt Lake City, Utah, Oct. 6-11.  
 California International Live Stock Show (Special), San Francisco, Calif., Nov. 1-8.  
 Missouri State Fair, Sedalia, Mo., Aug. 9-16.  
 Louisiana State Fair, Shreveport, La., Oct. 22-27.  
 Illinois Centennial State Fair, Springfield, Ill., Aug. 15-23.  
 Eastern States Agricultural Exposition, Springfield, Mass., Sept. 13-20.  
 New York State Fair, Syracuse, N. Y., Sept. 8-13.  
 Kansas Free Fair, Topeka, Kans., Sept. 8-13.  
 Interstate Fair Association, Trenton, N. J., Sept. 29-Oct. 3.  
 East Texas Fair (Special), Tyler, Tex., Sept. 29-Oct. 3.  
 Georgia-Florida Fair, Valdosta, Ga., Nov. 3-8.  
 Texas Cotton Palace, Waco, Tex., Oct. 25-Nov. 9.  
 Vermont State Fair (Horses), White River Junction, Vt., Sept. 9-12.  
 Washington State Fair, Yakima, Wash., Sept. 15-20.  
 Madison Square Garden Poultry Show, New York, N. Y., Jan. 20-25, 1920.  
 Boston Poultry Show, Boston, Mass., Dec. 30, 1919-Jan. 3, 1920.  
 Maryland Poultry Association, Baltimore, Md., Dec. 2-6.  
 Farmers' Week Agricultural and Industrial Exhibition, Hartford, Conn., Feb. 9-14, 1920.  
 United States Good Roads Associations, Hot Springs, Ark., Apr. 12-17, 1920.

#### ADMINISTRATIVE SUPERVISION.

When the administrative control and supervision of the Office of Exhibits was assigned to the Chief of the Division of Publications, along with a number of other units engaged in informational work, no immediate change was made in the personnel, and the work then under way, the fair season being at its height, was continued without interruption. Early in 1920, J. W. Hiscox was given immediate administrative charge of the work.

#### EDITORIAL, PRINTING, AND INDEXING WORK.

The editorial, printing, and indexing work of the division is under the supervision of B. D. Stallings.

#### EDITING.

The editorial work was directed toward the presentation of information in the briefest, most attractive, and most economical form. The manuscripts were edited with these three objects in view. The editorial and printing activities are reflected in the 589 new publications issued, which comprised the following: 58 Department Bulletins, 57 Department Circulars, 25 Soil Surveys, 21 Annual Reports, 30 Separates, 13 Miscellaneous Circulars, 4 Miscellaneous Bulletins and Reports, 21 Notices of Judgment and Decisions, 52 Service and Regulatory Announcements, the Yearbook, 61 Farmers' Bulletins, and 246 Periodicals.



## WORK WITH FARMERS' BULLETINS.

Much progress was made during the year in improving the appearance of the Farmers' Bulletins and in simplifying and clarifying the style of all publications. The Farmers' Bulletins have been made shorter, the policy of eliminating historical matter and scientific details having been continued, and technical terms have been avoided.

The use of specially designed covers has greatly increased the attractiveness of the Farmers' Bulletins, and the restriction of the material on the front page to the title, the number, and the department seal helps to make a forceful and interesting appeal when the bulletin first comes to anyone's attention. The text of the bulletins has been varied as much as the typographic limitations would permit, so as to bring out the striking features.

The number of Farmers' Bulletins issued during the year was 61, the editions of which aggregated 13,122,129 copies. The following is a list of the new numbers in this series:

- | No.   |  |
|-------|--|
| 1039. | Commercial Comb Honey Production.  |
| 1047. | Dry Farming Cultural Methods.  |
| 1051. | Sheep on Irrigated Farms in the Northwest.                                     |
| 1052. | Standard Varieties of Chickens. III. The Asiatic, English, and French Classes. |
| 1054. | The Loco Weed.   |
| 1055. | Country Hides and Skins.   |
| 1056. | Controlling Fungous and Insect Enemies of the Pear in the Humid Northwest.     |
| 1057. | Cattle Fever Tick.   |
| 1058. | Destroy the Common Barberry.   |
| 1059. | Sweet Potato Diseases.   |
| 1060. | Onion Diseases and Their Control.  |
| 1061. | Harlequin Cabbage Bug and Its Control.   |
| 1062. | Buckwheat.   |
| 1063. | Take-All and Flag-Smut, Two Wheat Diseases New to the United States.           |
| 1064. | Production of Late or Main-Crop Potatoes.                                      |
| 1065. | The Flat-Headed Apple Tree Borer.  |
| 1066. | Determining the Age of Cattle by the Teeth.                                    |
| 1067. | Feeding Hens for Egg Production.   |
| 1068. | Judging Beef Cattle.   |
| 1069. | Tuberculosis in Live Stock.  |
| 1070. | The Fowl Tick.   |
| 1071. | Making Woodlands More Profitable in the Southern States.                       |
| 1072. | Prickly Pear as Stock Feed.  |
| 1073. | Growing Beef on the Farm.  |
| 1074. | The Bean Ladybird and Its Control.   |
| 1075. | Unfermented Grape Juice—How to Make It.  |
| 1076. | The California Oakworm.  |
| 1077. | Game Laws for 1919.  |
| 1078. | Harvesting and Storing Ice on the Farm.  |
| 1079. | Laws Relating to Fur-Bearing Animals, 1919.                                    |
| 1080. | Preparation of Barreled Apples for Market.                                     |
| 1082. | Home Supplies Furnished by the Farm.   |
| 1083. | The Hessian Fly.   |
| 1084. | Control of American Foulbrood.   |
| 1085. | Hog Lice and Hog Mange.  |
| 1086. | How Insects Affect the Rice Crop.  |
| 1087. | Beautifying the Farmstead.   |
| 1088. | Selecting a Farm.  |
| 1089. | Selection and Care of Clothing.  |
| 1090. | Rabbit Raising.  |
| 1091. | Lining and Loading Cars of Potatoes for Protection from Cold.                  |
| 1092. | Prairie Rice in the United States.   |

1094. The Alfalfa Caterpillar.  
 1095. Beet-Top Silage and Its By-Products.  
 1096. Frost and the Prevention of Damage by It.  
 1097. The Stable Fly.  
 1098. Poisoning the Boll Weevil—Dusting Machinery.  
 1099. Home Laundering.  
 1100. Cooperative Marketing of Woodland Products.  
 1101. The Argentine Ant as a Household Pest.  
 1103. Growing Irrigated Grain in Southern Idaho.  
 1104. Book Lice.  
 1118. Dockage under the Federal Wheat Grades.  
 1120. Control of Apple Powdery Mildew.  
 1125. Forage for the Cotton Belt.  
 1126. Sudan Grass.  
 1128. Aphids Injurious to Orchard Fruits, Currant, Gooseberry, and Grape.  
 1130. Carpet Grass.  
 1131. Tile Trenching Machinery.  
 1134. Castrating and Docking Lambs.  
 1139. A Method of Analyzing the Farm Business.

A special effort has been made to present the results of the department's technical investigations in more popular form. It is believed that the editorial work has reduced the bulk of the published bulletins, reports, etc., at least 25 per cent.

The following table gives a comparative statement in the terms of new bulletins and reprints of the work done by this office during the last 10 years:

*New publications and reprints, 10 years, 1911 to 1920.*

Year.	New publications.	Reprints.	Total.
1911.....	1,170	696	1,866
1912.....	1,250	648	1,898
1913.....	1,771	429	2,200
1914.....	1,152	474	1,626
1915.....	913	393	1,306
1916.....	944	357	1,301
1917.....	1,132	390	1,522
1918.....	2,205	341	2,546
1919.....	840	401	1,241
1920.....	589	436	1,025

#### PRINTING.

Aside from the publications there was a large volume of miscellaneous printing, comprising blanks, circulars, blank books, etc., the aggregate number of such orders being 2,565. Work of this character was critically examined, paper stock selected, standard size adopted, and the number of copies kept within the actual requirements of the department.

This office examined engravings and lithographs used in illustrating the publications, made recommendations for awarding contracts for same, and conducting the negotiations relating thereto.

#### SUMMARY OF EXPENDITURES FROM THE REGULAR FUND FOR PRINTING AND BINDING.

The following statement shows the amounts expended from the appropriation for printing and binding, arranged by classes of printing:

*Expenditures from the regular fund for printing and binding for the fiscal year ended June 30, 1920.*

[Arranged by classes of printing.]

Class.	Amount.
Farmers' Bulletins.....	\$186,042.35
Department Bulletins and unnumbered publications.....	70,963.00
Periodical publications.....	151,570.85
Congressional publications.....	130,703.17
Compilations of laws, manuals, fiscal regulations, etc.....	1,940.60
Miscellaneous administrative circulars, orders, decisions, etc.....	14,432.25
Separates and unnumbered pamphlets.....	18,524.31
Posters, placards, labels, maps, etc.....	12,052.04
Binding.....	16,112.39
Printed cards (index cards and office forms).....	9,230.97
Blank forms.....	39,949.11
Blank books.....	5,649.58
Letterheads.....	7,159.98
Envelopes.....	134.98
Memorandum sheets.....	28.02
Total.....	664,493.60

#### PUBLICATIONS OF WEATHER BUREAU.

The Weather Bureau expenditures for printing and binding are not under the supervision of the Division of Publications, but in order to present a complete report of the publication work of the department, a list of the publications issued and distributed by the bureau is furnished, as follows:

*Weather Bureau publications issued during the year.*

	Total copies.
Monthly Weather Review, May, 1919, to April, 1920, 12 numbers.....	19,000
Index and title-page for vol. 47, Monthly Weather Review, 1919.....	2,400
Supplements Nos. 15, 16, and 17, Monthly Weather Review.....	6,425
Climatological data for the United States, by sections, April, 1919, to February, 1920, 11 numbers.....	3,410
Daily Washington weather map, first and second editions.....	391,441
National Weather and Crop and Snow and Ice Bulletin, combined, weekly.....	183,675
Forecast cards, daily, except Sundays and holidays.....	361,795
Weekly Forecast.....	9,100
Meteorological Summary for Washington, D C.....	3,855
Annual Report, Chief of Bureau, 1918-19.....	1,000
Circular F, reprint.....	2,000
Circular L, reprint.....	2,000
Daily river stages at river gage stations on the principal rivers of the United States, Vol. XVI, 1918.....	675
Radiographic Weather Code.....	300
Total.....	987,076

#### INDEXING.

The cumulated index of Farmers' Bulletins 1 to 1000 was the largest and most valuable piece of indexing completed during the year. The demand for the book began even before it was printed, and a large part of the edition of 1,000 copies was soon disposed of.



The indexing of Farmers' Bulletins in volumes of 25 each has been brought up to the volume for Nos. 1026 to 1050.

The indexes for volumes of Department Bulletins were also brought forward several volumes during the year.

The use of the card index for reference increased notably during the year, partly as a result of an announcement from the Division of Publications that lists of references to the department books for any subject could be furnished; but the use of the index is not as great as it should be. The making up of the lists of bulletins on the subjects of bulletins ready to print, for inclusion with the text, and the making of reference lists continued. A printed list of bulletins available for distribution was also prepared.

The number of pages of publications, department and others, indexed during the year was 37,338. This does not include the portions of the Congressional Record indexed here.

The indexing was under the immediate supervision of Charles H. Greathouse.

#### ILLUSTRATIONS SECTION.

The work with illustrations comprises drawing, designing, photographing, and the filing of electrotypes.

Drawings numbering 1,869 were prepared by the draftsmen and designers during the year, as compared with 1,760 for the preceding year. This is noteworthy in view of the fact that it was impossible to maintain a full working force throughout the year on account of the low statutory salaries available. The year closed with an accumulation of orders, some of which were canceled, because it was impossible to execute them within the time required.

##### *Drawings made for the various branches of the department.*

Office of the Secretary	367
Weather Bureau	1
Bureau of Plant Industry	301
Bureau of Animal Industry	387
Forest Service	60
Bureau of Chemistry	51
Bureau of Biological Survey	71
Bureau of Crop Estimates	47
Bureau of Soils	13
Bureau of Entomology	136
States Relations Service	93
Division of Publications	238
Bureau of Public Roads	39
Bureau of Markets	65
Total	1,869

The photographic work continued to increase. Several field trips to various parts of the United States were made to take photographs of a technical character.

The output of photographs totaled 190,316, as compared with 181,006 for the preceding year. This result was accomplished with a reduced working force due to the fact that it was impossible to fill vacant positions with competent photographers at the salaries provided. Following is a statement of the photographic work.

*Summary of photographic work.*

Contact prints.....	124, 050
Negatives.....	7, 925
Films and plates developed.....	4, 076
Bromide enlargements.....	2, 777
Bromides, colored.....	321
Maps and prints mounted.....	15, 152
Solar bromide prints.....	797
Lantern slides.....	19, 527
Lantern slides, colored.....	131
Transparencies.....	291
Transparencies, colored.....	115
Photostat prints.....	15, 132
Photomicrographs.....	22
Total.....	190, 316

Two hundred and fifty-eight requests for photographs were received from educational institutions and individuals outside the department, for which \$1,007.58 was received and turned over to the Division of Accounts and Disbursements to be covered into the Treasury.

The increase in photographic work, especially in requests from outside institutions, has taxed the small clerical force of the illustrations section to the utmost. Negatives from which prints are wanted are scattered throughout the bureaus and offices of the department without a uniform system of filing, which makes it extremely difficult to obtain them for making prints. A print from every photographic negative in the department that can be released for publication should be filed in the illustrations section. It is impossible to supply prints promptly without such a system. Supplying these prints to the public upon request is a valuable means of diffusing the department's information, and as this section is the one charged with the work, it must be able to locate a negative quickly, and to do so it should have a print of every photograph which may properly be given out.

Electrotype cuts kept on file were furnished for reprints of department's publications, and 2,614 new cuts were received and filed. Requests for 574 electrotypes were received from individuals and private concerns which were supplied through commercial houses under the usual conditions. Additional space is required for the storage of cuts.

The work with illustrations was under the direction of A. B. Boettcher, assistant in charge, until May, 1920, when he resigned. He was succeeded by J. H. Stevenson.

**DISTRIBUTION OF PUBLICATIONS.**

The total number of publications of all kinds distributed during the year was 45,237,747. This distribution was divided broadly into three classes, Farmers' Bulletins forming one class, Lists of Farmers' Bulletins a second class, and all other publications being classed as miscellaneous. The main distribution of miscellaneous publications was in accordance with schemes of distribution prepared in advance of their issuance. The distribution of miscellaneous publications totaled 25,274,618 copies. This was a reduction of 37 per cent in the distribution of miscellaneous publications. One reason for the reduction is found in the discontinuance of the great number of pam-

phlets distributed in stimulating production activities during the war. Another cause of this reduction is the policy of referring the great majority of requests for miscellaneous publications in bulk to the Superintendent of Documents of the Government Printing Office. This plan was strictly adhered to during the year.

A summary of the distribution of miscellaneous publications prepared by the various bureaus is given below.

*Publications other than Farmers' Bulletins distributed.*

	Copies.
Office of the Secretary.....	10, 271, 873
Bureau of Animal Industry.....	595, 038
Bureau of Biological Survey.....	34, 412
Bureau of Chemistry.....	273, 107
Bureau of Entomology.....	48, 382
States Relations Service.....	289, 534
Forest Service.....	822, 299
Library.....	775
Bureau of Markets.....	1, 428, 214
Bureau of Plant Industry.....	222, 707
Division of Publications.....	9, 389, 094
Bureau of Public Roads.....	49, 008
Bureau of Soils.....	22, 615
Bureau of Crop Estimates.....	1, 750, 529
Yearbook Separates.....	77, 031
Total.....	25, 274, 618

The principal distribution of Farmers' Bulletins was by direction of Members of Congress, totaling 7,233,347 copies. Upon orders received from the bureaus 2,716,429 were sent out, and 2,624,321 in response to individual requests received by the department, bringing the total distribution of Farmers' Bulletins up to 13,122,129. We were able to fill only about one-tenth of the requests received by the division directly, and we had to curtail the distribution requested by the different bureaus. The total number of Farmers' Bulletins distributed is approximately 4,000,000 less than the number distributed the preceding year, a falling off of 23.4 per cent. In addition to Farmers' Bulletins, 6,841,000 Lists of Farmers' Bulletins were furnished in response to congressional requests.

A comparative statement of the distribution figures for a series of years is given in the following table:

*Distribution of Farmers' Bulletins and all other publications, 1914 to 1920, inclusive.*

Year.	Farmers' Bulletins.	Other publications.	Total.
1914.....	14, 328, 976	14, 899, 790	29, 228, 766
1915.....	14, 528, 807	21, 673, 280	36, 202, 087
1916.....	12, 309, 742	26, 531, 915	38, 841, 657
1917.....	15, 432, 260	32, 480, 626	47, 912, 886
1918.....	23, 137, 529	76, 084, 792	99, 222, 321
1919.....	17, 159, 294	45, 059, 535	62, 218, 829
1920.....	13, 122, 129	32, 115, 618	45, 237, 747

**DISTRIBUTION TO MISCELLANEOUS APPLICANTS.**

During the year 523,146 communications requesting publications of various kinds were received, all of which received careful attention, including reading and interpreting the wants or desires of



applicants, as well as placing them in touch with officials in this and other departments to secure additional information. In handling this correspondence it was necessary to issue 130,684 orders on the Superintendent of Documents for miscellaneous publications, and 374,605 for Farmers' Bulletins, while 43,022 form letters were sent to persons requesting publications. Reference to other offices was made of 37,800 requests for information. In cooperation with other bureaus 10,455 addresses were written by the correspondence unit. Addresses to which the Yearbook for 1918 was sent were indexed, numbering 17,000.

#### CONGRESSIONAL CORRESPONDENCE.

During the year 36,406 communications were received from Senators and Representatives requesting publications. In addition to the addressing and counting of franks, the checking of lists, and the interpreting of requests, it was necessary to file 33,296 orders with the office of the Superintendent of Documents of the Government Printing Office. It was also necessary to count millions of franks and checked lists to ascertain the aggregate number of bulletins requested and chargeable to the accounts of Senators, Representatives, and Delegates. The work also involves in many instances the selection of the proper publications to be sent.

In connection with the correspondence incident to distributing publications, much stenographic and typewriting work is required. Although thousands of blank forms and fill-in letters are used in handling the great bulk of the correspondence, 15,289 letters were dictated and 4,395 were composed and written by the stenographic force, while 36,931 form letters were filled in and sent out. In addition to this, 3,173 letters originally routed to this office were referred to other bureaus and departments, making an aggregate of 59,789 communications handled by the stenographic force. Two hundred and seventeen stencils were cut in the stenographic room for use in connection with the work of supplying data for the press.

#### MAILING LIST RECORDS.

There was much activity in revising mailing lists during the year, many lists maintained both here and at the office of the Superintendent of Documents being revised, and a number of others that had become obsolete being discontinued. The work of revising mailing lists is going on constantly.

The distribution work was in charge of Francis J. P. Cleary, superintendent of distribution.

#### ADDRESSING AND DUPLICATING SECTION.

The multigraph work increased 26.5 per cent over the preceding year, 4,014,842 pages of such matter being run off. The number of mimeograph pages run off was 2,176,298. This was an increase of 3.88 per cent. Miscellaneous work comprising addressograph, graphotype, paper cutting, folding, assembling sheets of duplicated matter, stapling, round-hole cutting, etc., increased 44 per cent.

The task of transferring the permanent mailing lists to the addressograph system was completed during the year. The number of

employees engaged in addressing envelopes and franks for mailing publications has been reduced, while the output has increased. The present system permits more expeditious and efficient handling of all the work in connection with the addressing, care, and maintenance of the various permanent mailing lists now installed in the division.

The number of copies of publications of all kinds, circulars, press notices, etc., mailed by the folding-room unit aggregated 8,163,266 copies, a slight decrease compared with the preceding year and an approximate return to prewar conditions.

The addressing and duplicating section was under the supervision of C. E. Bracey, assistant in charge.

## REPORT OF THE CHIEF OF THE BUREAU OF CROP ESTIMATES.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF CROP ESTIMATES,  
*Washington, D. C., October 1, 1920.*

SIR: I have the honor to submit herewith the report of the Bureau of Crop Estimates for the fiscal year ended June 30, 1920.

Respectfully,

LEON M. ESTABROOK,  
*Chief of Bureau.*

HON. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### APPROPRIATIONS.

In presenting the situation of the Bureau of Crop Estimates, the conditions under which its work is carried on can not be clearly understood without reference to its annual appropriations. Prior to 1907 the appropriations of the bureau were less than \$200,000 annually and did not reach \$300,000 prior to 1917, the first year in which the United States took part in the World War. Interest in crop and live-stock statistics, especially in relation to the food supply, was greatly stimulated by the war, and the demands upon the crop-reporting and statistical service for such information increased steadily. For the fiscal year ended June 30, 1918, the bureau had a regular appropriation of \$323,452, which was supplemented by an allotment from war emergency funds of \$61,590, making a total of \$385,042. For the next fiscal year ended June 30, 1919, the regular appropriation was increased to \$346,232, with a supplemental allotment of emergency funds of about \$117,040, or a total of \$463,272. The regular appropriation for the fiscal year ended June 30, 1920, was \$371,102, which was \$92,170 less than the amount available the previous year.

The larger appropriations of 1918 and 1919 enabled the bureau to expand the crop-reporting service and to supply its branch State offices with much-needed equipment. Inasmuch as the demand for crop and live-stock statistics stimulated by the war has continued, it seemed highly desirable to continue the same service in the fiscal year 1920 as was furnished the preceding year. The attempt was made with an appropriation one-fifth less and in the face of higher cost of all stationery, supplies, and equipment, the difference in the appropriations being met by dispensing with the services of one-fifth of the clerical force at the Washington office and by making a



reduction of more than 50 per cent in the travel allotments of the field force. These measures, made necessary by the reduced appropriation, together with the rapid turnover of personnel due to inadequate salaries, greatly crippled the efficiency of the bureau and impaired the value of the service. Further difficulties were encountered when, at the last session of Congress, the appropriation for the fiscal year beginning July 1, 1920, was reduced about \$53,000 and it became evident that it would be necessary to discontinue special service for fruit, truck, potato, tobacco, rice, and cotton crops—crops having an annual value in excess of  $4\frac{1}{2}$  billion dollars. As soon as it became known in the spring of 1920 that the appropriation would be reduced the next fiscal year, the trained crop specialists of the bureau resigned to accept higher salaries in private employment or in other branches of the service. It was therefore impracticable to carry out the bureau's program of rendering the same service in the fiscal year ending June 30, 1920, with greatly reduced force and funds, as was furnished in the previous year.

## WORK ACCOMPLISHED.

### ADMINISTRATIVE OFFICE.

The administrative force was kept fully occupied with routine matters of administration, answering a growing correspondence, ordering and distributing supplies and stationery, accounting for bureau finances, preparing numerous statements for the press as a means of disseminating crop information, taking part in departmental conferences, service on bureau, departmental, and interdepartmental committees, and representing the bureau and the department at various public meetings of farmers and business men to present and discuss the statistics of crop and live-stock production. Early in the fiscal year the chief of bureau was designated as the personal representative of the Secretary of Agriculture on the Interdepartmental Committee of the Council of National Defense. An increasing number of problems required consideration resulting from the reduced appropriation and personnel of the bureau, the inadequate salaries and large turnover of employees, the loss of trained specialists and experienced employees, and the impracticability of replacing them even with inexperienced men at the salaries available, the inadequate travel funds, and the increasing public demand for service.

The Multigraph and Duplicating Section turned out 6,483,561 pages of material in the form of statements, circulars, questionnaires, and schedules of various kinds. The bureau was greatly handicapped by lack of adequate storage space for large quantities of stationery required, but it was found impracticable to secure the additional space needed until after the close of the fiscal year. The Mailing Section was equipped with a new automatic conveyor for assembling and mailing crop report schedules and enclosures of various kinds.

The Crop Reporting Board, made up of administrative officials and one or more State agricultural statisticians called into Washington each month, prepared and issued the monthly crop reports on the hour and minute fixed and announced the preceding December.

In the autumn of 1919 two Senate resolutions were passed requiring the Bureau of Crop Estimates to estimate the cotton acreage abandoned and to furnish a supplemental estimate of the condition of the cotton crop on October 25. The Bureau complied with both resolutions and the information desired was published in the October and November issues of the *Monthly Crop Reporter*.

In cooperation with the Bureau of the Census, this bureau collected from its crop reporters data on average prices of farm crops and live stock in each county for use in computing values for the 1920 census.

#### THE DIVISION OF CROP REPORTS.

The past year was probably the most difficult the Division of Crop Reports has experienced since its organization. The bureau's inability to pay adequate salaries to meet the greatly increased cost of living and the higher scale of wages in private employment, caused a continual shifting of employees, 16 having left the division during the fiscal year 1920. This resulted not only in the loss of clerical service during the time which necessarily elapses between the date of resignation and the appointment of a successor but in the necessity of continually training new employees, during which time their services are of little value. The expiration of the war emergency fund and the partial withdrawal of the help assigned by the Bureau of Markets for cooperative work on the live-stock report caused an approximate loss of an average of 18 employees (the number ranging from 12 to 28 throughout the year), or a decrease in the working force of the division of nearly 37 per cent.

Notwithstanding this decrease in the working force, projects begun during the war have been continued in addition to the regular crop and live-stock reports. During the year 3,384,834 schedules of inquiry were sent out by this division.

Increased difficulty was experienced in securing crop reporters and getting returns from them, probably on account of the shortage of hired labor and the extra work forced upon the farmer. Nevertheless, all of the lists and the number of schedules returned each month were maintained. The following table shows the number of reporters serving on each list:

*Number of crop reporters on the various lists.*

List.	1919	List.	1919
Township.....	34,500	Potato.....	5,700
County.....	2,750	Sheep.....	6,446
County aids (estimated).....	6,000	Maple sirup.....	2,270
Field aids.....	28,300	Truck.....	10,000
Special price.....	7,400	Apple.....	9,500
Live stock.....	17,500	Peach.....	3,500
Mill and elevator.....	19,990	Rice.....	500
Individual farm.....	50,000	Tobacco.....	360
Special cotton.....	4,650	Pear.....	2,500
Cotton specialist.....	2,135		
Honey bee.....	5,950	Total.....	219,861

An essential piece of work performed during the year which involved considerable labor was the checking and correcting of the bureau stencil lists of about 100,000 crop correspondents maintained in the Division of Publications and the Government Printing Office.

This had never been done before, and thousands of reporters who had left the service were found to be still listed for receipt of department publications, while many who should have been listed were not.

The past year has been a record-breaker for this division in the amount of work accomplished. Not since the organization of the bureau in 1862 has the Division of Crop Reports been called upon for such continuity of strenuous effort as during the fiscal year just closed.

The main project of this division consists in obtaining and tabulating information upon which the monthly Government crop report is based. As these data are secured through schedules of inquiry, sent to a list of voluntary crop reporters approximating 200,000 in number, a fair index of the increase in work is afforded in the statement that during the fiscal year 4,016,527 pieces of mail matter were sent out by the division as against 3,200,909 in the preceding year. This increase of 25 per cent in outgoing mail matter reflected a like increase in the work of editing, tabulating, and computing the schedules of inquiry.

Although a large number of our voluntary crop reporters entered the military service, those who remained on the farm, notwithstanding the scarcity of farm labor and the enormous crops to be handled, displayed a most commendable spirit in keeping the number of reports up to the point where accuracy was assured in the estimates.

In addition to the regular monthly inquiries, special investigations through the voluntary crop reporters were made at the request of the United States Food Administration, the Bureau of Plant Industry, the Office of Farm Management, and the Office of Fertilizer Control.

The monthly investigation as to live-stock changes on farms, to ascertain the number of various classes of animals on farms on the 1st of each month, and the changes taking place during the month through birth, purchase, slaughter, loss from disease and shipment, is a project deserving of greater development than was possible with the limited clerical assistance available; however, the division succeeded in doubling the number of live-stock reporters.

The various mailing lists of voluntary reporters show slight increase over last year.

Fifty-seven county outline maps, 34 county outline United States maps, and 11 State outline United States maps showing graphically production of crops and live stock were prepared during the year.

#### DIVISION OF CROP RECORDS; FOREIGN CROP RECORDS AND RESEARCH.

The foreign crop records consist of a permanent file covering the final or revised figures on acreage and production of all crops for all years reported, and for nearly all countries as they were constituted before the war, and some records have been made for newly organized countries in Europe. The file also contains a ready reference-card index, and various summary tables giving recent statistics and crop news.

These records are used to furnish statistics principally on the following subjects: Prospective crops or supply, current crop conditions, recent estimates of acreage or production, names and relative importance of countries producing a surplus of a given crop, and consumption of agricultural products by countries, and also for



detailed study by investigators, these files being open to all persons who care to use them. These records also furnish data for tables and charts in the Monthly Crop Reporter, for the crop news and recent statistics published in the semimonthly Foreign Crop and Live Stock Reports, and for the world tables of crops and live stock in the Department Yearbooks. Carbon and photostat copies of the more useful tables are duplicated and kept on file for reference and for distribution.

The foreign project is limited to products on the farm and includes acreage, production, and value of crops, also number and value of live stock. In this work close cooperation is maintained with the foreign marketing service of the Bureau of Markets, which frequently consults the Division of Crop Records, and submits manuscript to it for revision, especially when the subject refers to agricultural production or number of live stock.

These sources of foreign crop statistics are more plentiful than they were in the fiscal year 1919. Countries which reported during the war send a few more reports than previously, and official estimates are received from central and southeastern Europe, including Alsace-Lorraine, Germany, Austria, Czechoslovakia, Roumania, and Greece. Also the International Institute of Agriculture reports for more countries than it did during the war.

The foreign crop project is under the direction of a specialist, who was trained by an expert of many years' experience as foreign crop specialist in this country and Europe. The specialist in charge compiles and edits material for the semimonthly reports, prepares replies to letters, compiles special tables, and supervises the work on this project. One regular assistant, who is an editorial clerk and typist, and who translates several foreign languages, collects items from foreign publications and summarizes them for the semimonthly reports. One statistical clerk was kept regularly on this project during the fiscal year 1920, and one more has been assigned for 1921. Typists and statistical clerks are assigned to this work from time to time.

The success of the foreign crop work depends much upon the experience and ability of the leader. To understand the foreign reports properly and to interpret them for use, the specialist should understand clearly the methods and limitations of each of the foreign crop reporting systems as well as the agricultural and related economic conditions of those countries; therefore, it is desirable that one or more specialists be sent to foreign countries to study these systems first-hand. Although the Bureau now receives practically all the official crop reports directly from the respective governments and advance quotations from some of them through the American Consular Service and the International Institute of Agriculture, nevertheless a foreign representative of the Bureau of Crop Estimates would be able to supplement these official reports by comments on crop conditions and work up useful and timely reports by personal inspection and interviews which would hardly be expected of a consul or a commercial attaché. To avoid delay some of these reports should be sent by cable or radiograph, worked into press notices in the Washington office, and given to the public not later than the day following their receipt.

The better understanding of the foreign statistics and the personal contacts established by these representatives and the prompt transmission of the foreign crop and live-stock reports would make them much more useful and valuable.

If foreign representatives are appointed, it is recommended that one be placed in Europe, with headquarters at London or Paris; another in South America, with headquarters at Buenos Aires, and a third in the Orient and Australia.

The foreign "crop records and research" project includes the international trade in about 23 agricultural products. Exports from and imports into practically all countries are compiled from the official returns of the respective governments, about 200 in all, and computed to United States weights and measures. Like the original sources for foreign crop and live-stock statistics, many of these trade returns are in foreign languages, without any English translation. These "international trade" tables are useful in comparison with the statistics of production, and are prepared in this bureau because no other Government office compiles them.

#### INTERNATIONAL INSTITUTE OF AGRICULTURE.

According to former custom, monthly crop reports have been sent regularly to the International Institute of Agriculture during the fiscal year. A copy of each report was sent by radiogram through the United States Navy Department; also by mail direct to the Institute. At the request of the Department of Commerce and the Institute, the exports and imports of cereals and cotton for the United States were also given in monthly radiograms and mailed schedules, through the Bureau of Crop Estimates. In addition to the regular monthly reports the following special compilations were sent to the Institute:

- Stocks of cereals on farms and in markets.
- Estimated consumption of cereals in the United States.
- Statistics of fertilizers, showing production, exports, and imports for the United States.
- Comprehensive statistics of forestry in the United States, including a description of the scope and methods of compiling the statistics; also copies of the publications.

A monthly crop summary is received from the Institute by radiogram at the Bureau of Crop Estimates, transmitted through the courtesy of the State Department. These summaries are computed to United States weights or measures, edited for the press, and sufficient copies run off for distribution through the Office of Information.

The incoming reports are checked by a research clerk in consultation with the foreign crop specialist, to guard as much as possible against errors. The outgoing reports to the Institute are in direct charge of the Assistant Chief of the Division of Crop Records.

The publications of the Institute are received and distributed by the States Relations Service.

It is recommended that funds be appropriated to pay cablegram charges, and that the Institute be requested to cable these monthly reports direct to the Bureau of Crop Estimates. This will insure more speedy delivery.

## DOMESTIC CROP RECORDS AND RESEARCH.

The official records of the reports made by the Bureau of Crop Estimates, beginning with 1865, are on file in the office of the assistant statistician. Special tables compiled from these reports are kept for reference in the Division of Crop Records, and duplicates of these tables are kept for distribution. These tables include various comparisons of acreage, yield, and value of crops, dates of planting and harvesting crops, number and value of live stock, monthly farm prices and wholesale prices, tobacco sales by counties (compiled from unpublished records of the Internal Revenue Bureau), and extracts from census reports. There are also tables of freight rates on agricultural products by rail, ocean, and lake, beginning with 1881, but not kept up to date, since this work is no longer a part of the Crop Records project.

County yields per acre for various crops, beginning with 1911, are compiled and kept up to date; also records of agricultural and live-stock statistics, as published by State authorities, have been drawn off in convenient form for reference. The domestic crop records include also a special file of copies of letters which were written giving agricultural statistics on various subjects.

These records are used in current correspondence, in consultation with visitors who call for information, and in preparing material for the Monthly Crop Reporter, the Department Yearbook, and other publications.

The sources of the domestic crop statistics on file in this division are, as has been mentioned, the basic records of the bureau; also reports of the United States Bureau of the Census, the Bureau of Markets, commercial periodicals, boards of trade, internal-revenue records, State statistical offices, the Philippine Department of Agriculture, and the Porto Rican Government. No statistical reports are received from Hawaii other than the sugar-production report issued by the Hawaiian Sugar Planters' Association, but the Division of Crop Records compiles annually, from returns made direct by the Hawaiian sugar agents, detailed statistics of cane and sugar.

The work connected with domestic crop records and research is assigned to a few specialists, each of whom has one or more subjects to follow. A stenographer in charge of the correspondence files attends to the proper indexing and summarizing of these files, also to keeping copies of up-to-date duplicate tables on hand in sufficient numbers for distribution. Statistical clerks, stenographers, and typewriters are assigned, as they are needed and are available, to assist a specialist or research clerk. These assignments are changed from time to time, according to the needs of the current investigations. Most of the clerical work is under the supervision of the assistant chief of the division.

## SURPLUS AND DEFICIENCY INVESTIGATIONS.

Among the records of this division are many tables pertaining to a subject that is named "surplus and deficiency." The purpose of these tables is to arrive at a demonstration of the alternative fact for each agricultural product that its production affords either a national surplus above consumption or a deficiency that is balanced



by imports. In the process of working to these conclusions many statistical facts are involved, such as national production, acreage, production per acre, and per capita of the population, total and per capita consumption, and the ratio of exports to production and of imports to consumption; and the statistics and relationships among them are carried back, where possible, at least to the estimates of crop production made by this bureau in 1866, to the first agricultural census for 1839, and in some cases to years much earlier, and, for foreign trade, at least to the fiscal year beginning in 1850, sometimes back to the beginning of the Republic, and even earlier.

These tables are little concerned with prices and values; the important fact for their purpose is the product, and not its worth. Yet there is some effort to state both price and value. In connection with the essential plan of these records, numerous subsidiary tables and explanations have been accumulated. This great mass of information has provided ready responses to numerous and constant requests, whereas for want of this previous preparation a response often could not have been made or, at the best, only after the lapse of considerable time. Substantially all of this matter awaits publication.

Three Yearbook articles and one department bulletin, containing results of this investigation, have already been published. The Yearbook articles related to wool, hides, and tobacco, and the bulletin summarized the data on potatoes.

#### WEEKLY CROP NOTES.

Weekly reports on crop conditions are transmitted by the bureau's agricultural statisticians in the different States to the Washington office, where they are summarized and edited on Monday and Tuesday of each week. These summaries, which give the principal recent changes in crop and live-stock conditions, are mimeographed, and an edition of about 350 copies is run off primarily for the information and guidance of the department heads and the field service, and with a limited distribution to farmers' organizations, publications, State agricultural workers, business agencies, etc.

The editing and summarizing of these statisticians' reports is in charge of a specialist, with one assistant.

#### ESTIMATES OF SUGAR CROPS.

In connection with the project of crop recording and abstracting, estimates are made of the sugar crops of the United States and Hawaii. The cane and beet-sugar reports, being practically an annual census and confined to a relatively small number of producers, are conveniently handled in connection with crop recording and abstracting. During the fiscal year 1920 the beet-sugar reports included estimates of acreage planted, five monthly forecasts of beet and sugar production, preliminary report in December of acreage and production of beets, also output of sugar, production and acreage of sugar-beet seed, and in April, 1920, final report of acreage, production, and price of sugar beets, and production of sugar. Estimates of sugar cane consisted of two reports on acreage for each State; one on sirup production; five monthly forecasts of the

Louisiana sugar crop; a preliminary report in December of Louisiana and Texas sugar; and a final report on Louisiana sugar in April, 1920. The report on maple sugar and sirup production, based chiefly upon estimates of the bureau's agricultural statisticians, was issued in May, 1920; and the annual estimate of Hawaiian cane acreage and production, and sugar production, by islands, was made from factory reports and published in January, 1920. This Hawaiian report has always been made by mail and without direct contact with the industry. It would, no doubt, be more useful if some representative of the bureau could spend a few weeks in Hawaii and become acquainted with plantation and factory methods, records, and reports.

#### LIBRARY.

The library of the Bureau of Crop Estimates contains one of the most complete collections of foreign and domestic agricultural statistics. It includes not only Government reports from practically all countries, but also statistical reports of boards of trade and other commercial and agricultural associations, and files of agricultural and commercial periodicals relating to statistics. The library is, of course, an essential part of the crop recording and abstracting project; and it is also used constantly by investigators not connected with the bureau.

The total number of foreign and domestic publications, different titles, received during the fiscal year ended June 30, 1920, was 1,367, an increase of 262 over the number received last year. These consist chiefly of agricultural and horticultural publications; reports of boards of trade, comptrollers, chambers of commerce and auditors; live stock and tax reports; and daily, weekly, monthly, and quarterly periodicals received currently. Part of the increase is due to the resumed publication of a number of the foreign periodicals which were suspended during the war. Of the above number of publications, 621 were foreign and domestic annuals and 746 were issued as follows: Forty-five daily, 40 domestic, and 5 foreign; 152 weekly, 105 domestic, and 47 foreign; 259 monthly, 164 domestic, and 95 foreign; 290 quarterly and irregularly, 150 domestic, and 140 foreign. These figures represent approximately 30,621 pieces recorded and do not include the many duplicates which are handled without any record.

#### PUBLICATIONS.

The following publications of the department were prepared in the Bureau of Crop Estimates during the fiscal year 1920:

- Monthly Crop Reporter (printed), 12 issues, total 140 pages.
- Foreign Crop and Live Stock Reports (mimeographed), 24 issues, total 206 pages.
- Weekly Crop Notes, semimonthly in winter (mimeographed), 39 issues; total 400 pages.
- Crop Estimates, 1910-1919: A summary of Area, Average Yield, Production, and Exports (or Imports) of Agricultural Products for the United States. By Leen M. Estabrook.
- Department Bulletin 806: Peaches: Production Estimates and Important Commercial Districts and Varieties. By H. P. Gould, Bureau of Plant Industry, and Frank Andrews, Bureau of Crop Estimates.

Department Bulletin 822: Pears: Production Estimates and Important Commercial Districts and Varieties. By H. P. Gould, Bureau of Plant Industry, and Frank Andrews, Bureau of Crop Estimates.

Yearbook Separate 805: Three Centuries of Tobacco. By George K. Holmes.

Statistical tables (321 in all) in Department Yearbook for 1919. To be reprinted in fiscal year 1921 in five pamphlets ("separates").

#### ESTIMATES OF COMMERCIAL CROPS OF FRUIT AND POTATOES DISCONTINUED.

Estimates of the production of commercial apples, by States and by regions, together with comments, were made each month of the fiscal year from July to December, inclusive. Similar reports were made for peaches from July to September, inclusive, and for pears from July to November, inclusive. The first reports for the season of 1919 were of course made prior to July 1, the first peach report occurring in April. These estimates and comments were used as a guide by many growers and fruit organizations as well as by other persons connected with or interested in the fruit-growing industry. An official of the Eastern Fruit Growers' Association estimated these apple reports for one season alone to be worth more than a million dollars to the growers in his territory. The season of 1920 opened with the peach report of April, which was made under trying conditions and met with success. A freeze occurred in the Southwest about April 5, after the regular mailed schedules had been received and tabulated. For the States affected by this freeze, the tabulated figures were useless, so a telegraphic inquiry was made at once, and satisfactory estimates made for the injured regions. This was the last report of the series, owing to the resignation of both the fruit crop specialists. They left the service to accept other positions in anticipation of their work being discontinued at the end of the fiscal year 1920, necessitated by a reduction of the appropriation. It is recommended that a fruit crop specialist be employed to take the lead in reestablishing the commercial fruit crop estimates on a country-wide basis.

An attempt was made to estimate for the United States the commercial main crop of potatoes. The bureau's statisticians in the principal commercial late potato States were called to Washington in January, 1919, and plans were made for this work, which was to be done by each statistician for his own State. Another meeting was held in Waupaca, Wis., which was attended by the bureau's agricultural statisticians of three States, one of the fruit crop specialists and the Chief of the Division of Crop Records. At this meeting plans were made for certain parts of the work not covered by the January conference. The commercial potato reports were issued monthly from July to December, 1919, with one semimonthly report in September. The data for each State were sent to the fruit crop specialists in Washington, where a summary for the United States was made, and transmitted back to the different States, where it was published. A limited number of copies were circulated also from the Washington office. While this work has continued in some States, it is not as satisfactory as it should be, because some important regions are not represented in the reports. These commercial estimates are of great value and should be reestablished at the earliest



moment. Specialists should be appointed to reorganize and coordinate the work and to prepare for publication summaries and analyses of the data collected.

#### TRUCK CROP REPORTING SERVICE DISCONTINUED.

The truck crop reporting project was organized in 1914 with a truck crop specialist in charge. The first reports related to the cabbage and onion crops of the North in the fall of 1914 and were followed by a general survey of the winter trucking regions from Florida to California. Two assistant truck crop specialists were provided in January, 1917, one being assigned to the Atlantic Coast States and the other to the Pacific coast, including Idaho, Utah, Colorado, Nevada, Arizona, and New Mexico. A third assistant crop specialist was assigned to the Mississippi Valley region in 1918. Reports on acreage, condition, yield per acre, total production, and prices to producers for about 30 truck crops were prepared and published in the Weekly Truck Crop News and the Monthly Crop Reporter. Special reports were made on canning crops, such as tomatoes, corn, peas, snap beans, cucumbers for pickling, and cabbage for kraut, upon which forecasts of the resulting pack were based. Returns were secured from about 10,000 special truck crop reporters, and supplementary information was obtained by travel, personal inspection, and interviews with well-informed men in the trucking regions by the specialists.

On April 28, 1919, there were engaged upon the truck crop project 1 specialist, 4 assistant specialists, 9 permanent and 2 temporary clerks, or a total force of 16 employees. By November, 1919, the clerical force was reduced to 4, and about 45 different questionnaires relating to truck crops had been mailed out and returned which could not be tabulated. On May 1, 1920, the force was still further reduced to 1 specialist and 1 clerk, and the work was practically discontinued except for the mailing out of a few special schedules. A few reports on acreage and condition continued to be made occasionally as time was found to tabulate and summarize returns without interfering with the reports on crops of major importance. The Weekly Truck Crop News service was discontinued in the winter of 1919-1920. The annual value of truck crops in the United States is estimated to be approximately \$185,000,000. The total cost of maintaining the truck crop reporting service for the fiscal year ended June 30, 1920, was about \$26,000, and the value of the service to truck growers alone is estimated to have been nearly \$2,000,000.

#### FIELD SERVICE.

The field work of the Bureau has shown notable improvement during recent years, and while expansion during the last year has not been possible owing to reduced appropriations, yet marked progress was made in the development and improvement of the lines of work already inaugurated, although the field statisticians were much hampered in preparing their estimates by the limitations upon travel and investigation in the field. The further reduction of the appropriations for this work during the fiscal year 1921 forced, toward the

close of the year, a serious reduction in the force of our trained field statisticians and the abandonment of important lines of work.

The plan of preparing and issuing a single crop report by Federal and State agencies jointly, instead of separate and often conflicting reports, first undertaken in Wisconsin in 1917, has proved so advantageous in every way that it has now been adopted in 21 States, having been extended this year to Maine, New Jersey, Kentucky, and California. Under this plan the Bureau of Crop Estimates through its resident agricultural statistician, furnishes the technical supervision and direction of the work, the facilities and personnel of both agencies are utilized, expenses are equitably divided, and data are collected and published jointly.

The resulting economies, the improvement in the reports, and their enhanced value to the public are most gratifying. The plan will be extended to other States in which suitable State agencies exist as rapidly as the State officials are prepared to utilize its advantages, which are in brief, avoidance of duplication of work and of divergence of results, increased accuracy, enlarged service, fuller detail, and greater public confidence, utilization, and benefit.

Cooperation with agricultural extension departments under formal agreement has been undertaken in a few States, and the possibilities of service to farmers through this relation are so great that the plan should be rapidly extended.

Cooperation with county agents has been informal but active to the degree permitted by their interest in crop estimates and agricultural data and their ability to assist. They help most by establishing contact between the bureau and representative producers and farm organizations, and by encouraging producers to report to the bureau and make use of its reports.

Cooperation recently undertaken with farm bureau organizations, State, county, and community, offers great possibilities of service to their members and other farmers. The farmer has suffered heretofore from his failure to be acquainted with and to make proper use of available agricultural data relating to his business even more than from lack of such information. The farm bureau organization provides an agency through which the average farmer may become reasonably familiar with this subject, encouraged to assist in the preparation of the Government estimates, and learn to profit by them directly, instead of merely indirectly through their stabilizing influence on market prices.

The crop-reporting service is now cooperating under formal agreements with the State farm bureau organizations in Ohio, Indiana, Michigan, Iowa, Missouri, and Kansas in the collection of live-stock data. The project to furnish to the live-stock producing interests statistics on live stock comparable with those now furnished for staple crops failed last year to receive the approval of Congress. The need for this information is so great that the State farm bureau organizations in Indiana, and subsequently those in the other States named, provided the necessary funds and the cooperation of the organization and its membership in the collection, summarization, and publication of such data. The farm bureau organizations in several other States have requested the same service, but the limitations upon the personnel, equipment, and travel funds of the State offices of the

Bureau of Crop Estimates have made it inadvisable to attempt the further extension of the plan until these deficiencies are remedied.

The items covered by the present cooperative inquiry are:

- Numbers on hand, monthly, of cattle, sheep, and swine.
- Increases by birth and purchase.
- Decreases by sale, slaughter, and death.
- Numbers remaining.
- Proportion of cows, calves, steers and bulls, and brood sows.
- Numbers of each class being prepared for market during ensuing 90 days.
- Probable date of marketing.
- Probable weight when marketed.

Concerning such matters, the large buying interests are in position to inform themselves. The producer and the public generally are in equal need of this information and it is the proper function of the Government to furnish it.

An ideal toward which the bureau is working is the association of all public agencies immediately concerned in production and marketing of agricultural products into a closely cooperating group, to participate in collecting information for the crop estimates, and in utilizing the published results to the greatest advantage to producers and the general public.

In Idaho, cooperation is now established between the crop reporting service and the three other leading public agencies, namely, the State commissioner of statistics, the State agricultural extension service, and the farm bureau organizations. Each agency shares in the work and expense and the estimates are issued jointly. The agricultural extension service, through the county agricultural agent, encourages the creation by the farm bureau of crop reporting committees in every county and community center. These report local conditions to the agricultural statistician and receive, study, and disseminate the State and county reports issued by him. The statistician visits the different counties with the specialists of the agricultural extension service to discuss this phase of the farming business at the county and community meetings. Reports prepared under such conditions of general participation by those most immediately concerned are recognized as dependable, inspire confidence, and are widely and profitably used.

The annual collection by county assessing officers of basic agricultural statistics, principally the acreage planted to each crop, under State laws, is now practiced in 21 States and has been of great benefit. The wide adoption of this plan resulted from the experience during the war emergency, when States like Kansas, with such laws in operation, were able to obtain definite data regarding county food and feed production and supply, while States not having this means of ascertaining the facts were suffering great anxiety, inconvenience, and damage from the lack of such knowledge.

The crop reporting service has lent every assistance and encouragement to this movement, because data secured in this manner furnish the most perfect check yet devised on the accuracy of its estimates and permit of an annual revision to a sound basis of any estimates that are affected by bias or error, instead of permitting inaccuracies to accumulate in the annual forecasts during the 10 years intervening between Federal censuses. It will also permit the issu-



ance by this bureau, monthly, of county and district estimates for important products, which would be unsatisfactory without such an annual check.

It is hoped that such a law will be speedily enacted in every State. The benefits of such full and dependable data concerning the State and each county annually are very great to agricultural producers, and to all business interests affected by farm output and purchasing power.

The Weekly Crop Notes issued by the agricultural statisticians for each State, and summarized in the bureau by crops and States, showing in general terms the crop changes in the interval between the monthly Government reports, have become increasingly valuable. These should be given wider publicity to keep the public informed of actual changes taking place, thus acting as a check on misleading crop statements put out in the interval between the regular monthly reports and assisting in stabilizing market prices.

In the internal work of the field offices much progress was made in unifying methods of summarizing and interpreting the great volume of statistical data that forms the basis of the current estimates and the background for necessary comparisons with past years, without which, current figures, however accurate, are of little practical value. In the different States the problems of securing a maximum of practical uniformity without suppressing the personal initiative of the agricultural statistician is made extremely difficult by the great diversity of the crops principally grown, the methods of handling and disposing of them, the farm practices, the dates of harvesting, the tendencies of reporters toward bias, etc., as well as in the amount and character of data available. Another important step in raising the efficiency of the field service has been the standardizing of the field office filing systems, basic records, and office systems. The process of so unifying the office arrangements is about 70 per cent complete and the results have amply justified the time and expense involved. With few exceptions the agricultural statisticians are men whose training has been along lines other than office procedure. Notwithstanding this fact most of them now maintain their files and records according to a carefully devised plan, which makes it possible for any officer of the bureau when inspecting a field office or for any statistician upon transfer to a new territory to have instantly at his command the essential records of the office.

So far as feasible under the present handicap of reduced appropriations, data are being worked up on a county basis, and in many States, especially those in which cooperation with State agencies provides additional facilities and funds, county as well as State reports are being issued for important crops, thus adding immensely to the value of the service.

Considerable development has occurred this year in the preparation by the field statisticians of special articles, charts, maps, and exhibits of various kinds showing the outstanding features of the crop conditions, prospective yields, supply, stocks, prices, etc. The advantages of this form of presentation of agricultural statistics and estimates are, that while important facts embodied in an article or table may not be generally read or properly understood, even by those deeply interested in a financial way, such facts can be presented

by means of charts, maps, graphs, and diagrams, which are really pictures, in striking and easily understood forms to the mind of the average man. Also, because of their attractiveness as news matter, they secure an immensely increased circulation through newspapers, magazines, farm journals, and the like, which are disinclined to print simple statistical tables and text, no matter how important, because of the tradition that statistics are "dry" and not interesting "news" matter. In the State of Georgia, for instance, the Agricultural Statistician obtained for material carrying maps and charts a newspaper circulation equivalent to 5,000,000 copies monthly, while the same reports sent direct from his office to individuals amounted to only 2,000 copies monthly. Like results are reported from many other States. This growing utilization of crop reports, coupled with the fact that the offices of the agricultural statisticians are visited daily by representatives of newspapers seeking such news matter, indicates the growing interest in and importance of crop estimates.

The value of the estimates put out by the bureau and its field representatives would be many times multiplied if proper facilities were provided through adequate equipment, sufficient compensation to secure and hold men of the requisite technical training and mental caliber, and necessary clerical assistance.

It is an unhappy commentary upon the poor business methods of the Government that the agricultural statistician for Georgia, just mentioned, the worth of whose services to the farmers and business men of that State can hardly be estimated, was compelled to resign and go into commercial work to secure a living salary, the Government paying him less than the wage of a skilled mechanic.

These accomplishments of the field service have been in the face of conditions of utmost discouragement. Following a reduction of 25 per cent in the appropriations of the bureau for 1920, Congress still further reduced the appropriations for 1921 by 20 per cent, or to a figure about equal to that of 1914, with price levels now more than double. The result of this action was to reduce the clerical force one-fifth and force the resignation of one-fourth of the bureau's trained technical employees, including many of its best men; to hold at unjust and disheartening salaries those whose long years of training, special adaptability, and devotion to the work prevents them from sacrificing public service for personal gain; to practically cut out all travel by them for the investigation and inspection of crops in the field, which is essential to full understanding and correct conclusions; to limit needed clerical assistance and lower its level of efficiency; to restrict through absolute shortage of paper and envelopes the collection and dissemination of the information which the bureau is maintained to furnish; and to force the discontinuance of many reports of demonstrated financial value to producers and business men.

The present unprecedented movement among agricultural producers toward organization for general and cooperative purposes has as a principal object the solution of the one big remaining problem upon which the future welfare of agriculture in this country depends, namely, the satisfactory marketing of farm products under conditions insuring just treatment to all. This purpose can not be successfully accomplished without full, dependable, and country-wide data on crop prospects, volume of farm production, and farm reserves.

The Bureau of Crop Estimates, being the Federal agency created for that purpose, should be strengthened to adequately meet this need.

That agriculture is undergoing great changes is evident to all who observe and reflect on the great movements now under way. These changes will affect the standard of living and the cost of living of the entire population, and should therefore be effected wisely and along conservative lines, which is possible only on the basis of full information regarding the essential statistical facts of agriculture. Economy is necessary, but it is the reverse of true economy to cripple any branch of the public service by inadequate appropriations which is so vital to the proper development of a stable and profitable agriculture as the crop-reporting service.

To encourage production workers must expect a fair reward. To the farmer this reward must come through fair prices; these in turn from correct general knowledge of relative supply; and this can come only from unbiased and accurate Government crop reports, based upon adequate information summarized by competent men.

#### COUNTY AGENTS AS CROP REPORTERS.

Because the county agent is prominent as a leader in promoting better methods of farming, is widely known to and in close touch with farmers in his county, travels over the county frequently, devotes his entire time to the work, receives a regular salary, has an office, a clerk, and equipment, and because he represents the county farming interests, the extension service of the State agricultural college and the States Relations Service of the United States Department of Agriculture, it is naturally assumed by many people that he would make an ideal crop reporter, and the suggestion is frequently made that the county agent should be utilized to the exclusion of other sources of information by the Bureau of Crop Estimates. Members of the two agricultural committees of Congress in its 1919-20 session seemed to be of the opinion that county agents can be utilized for crop estimating work at a considerable saving in expense, and this reason was assigned as the principal justification for reducing the already inadequate appropriation of the Bureau of Crop Estimates. This belief is wholly theoretical and will not work out in actual practice, as has been fully demonstrated by the bureau through repeated attempts to utilize them ever since there have been any county agents.

The Bureau of Crop Estimates realizes that county agents are one of the best sources of information through which its State agricultural statisticians and crop specialists can ascertain quickly the names and addresses of well informed and experienced farmers in their counties and for this purpose they are used extensively. However, the bureau has been forced to recognize certain limitations which make it impracticable to rely upon county agents as country-wide and State-wide bases for its crop estimates. These limitations are, briefly: (1) About one-third of all counties in the United States have no county agents, and no system can be uniform in its application with such gaps; (2) in many counties, if not in all, it is a rule not to appoint legal residents of the county as county agents, so that in such counties they can not be expected to be thoroughly familiar



with local conditions and they have no basis for making crop reports which will be comparable with preceding years; (3) their period of service in some counties is relatively short, they are constantly shifted about and the turnover is frequent, which prevents them from being in position to furnish comparable data one year with another; (4) statistical training and experience is not one of the qualifications required for appointment as county agents, yet statistical work is as much a specialty as accounting, or horticulture, or commercial fruit growing; (5) while some county agents have a natural inclination to take an interest in the statistical side of production and therefore can be used to splendid advantage by the bureau, they are few in number and it is exceedingly difficult to interest the relatively large number of county agents who have no such inclination; (6) county agents are employed primarily for entirely different purposes than collecting and summarizing statistical data, their main purpose being to promote better and more profitable methods of farming, which is a job of sufficient size to absorb all their energies; (7) in many counties practically their entire salaries are paid from the local funds and their responsibility is directly to local authorities. Because county agents are fully occupied if not overburdened with duties which have little or no relation to crop estimating, experience has shown that on the average the number of replies received from inquiries addressed to county agents is less than from other classes of reporters. The reluctance of county agents to report to the bureau in some cases and their inability to report on account of other duties in many cases, and the fact that nearly one-third of the counties are without any county agents, are fatal to any plan of relying upon them as a principal or main source of data for crop estimating on a uniform and country-wide basis. In the circumstances they can be utilized to advantage only as a supplemental source of information.

Any plan to utilize county agents successfully in crop-estimating work, with exceptions in a few States only, where conditions are especially favorable, will involve increased expense for necessary supervision, instruction, training, administration, and for summarizing and interpreting data supplied by them. The situation with respect to utilizing county agents in crop-estimating work has been thoroughly canvassed with the States Relations Service and the limitations mentioned are recognized. Several plans are under consideration for development, with a view to the wider utilization of crop reports by farmers through encouragement and assistance by the county agents, whenever the necessary funds are provided without which the plans can not be made effective. One of these plans involves the employment of at least four regional extension specialists in crop estimating whose entire time would be devoted to instructing county agents and extension leaders in the technique of crop estimating and educating them in the value, interpretation, and practical use of crop reports in the business of farming.

#### ACCURACY OF THE CROP ESTIMATES.

The value of the crop and live-stock estimates depends upon their accuracy, timeliness, and amount of detail. The degree of accuracy of the estimates can be determined only approximately for most

crops by checking against such figures as are available for crop movement, receipts at primary markets, and exports. In the case of the cotton crop, however, an absolute check is afforded by the annual census of the number of bales ginned. The following table shows the annual estimates by this bureau in December in comparison with the annual report of bales ginned by the Bureau of the Census the following March:

*Annual cotton estimates of the Bureau of Crop Estimates, compared with annual Census reports of cotton ginned.*

Crop year.	Pounds of lint cotton (000 omitted).		Over- estimated.	Under- estimated.
	Estimated by Department of Agricul- ture.	Finally re- ported by Census Bureau.		
			<i>Per cent.</i>	<i>Per cent.</i>
1900.....	4,856,738	4,846,471	0.2	
1901.....	4,529,954	3,440,940		0.5
1902.....	5,111,870	5,091,641	.4	
1903.....	4,889,796	4,716,591	3.7	
1904.....	6,157,064	6,426,698		4.2
1905.....	4,860,217	5,060,200		4.0
1906.....	6,001,726	6,354,110		5.5
1907.....	5,581,968	5,312,950	5.1	
1908.....	6,182,970	6,336,070		2.4
1909.....	4,826,344	4,783,220	.9	
1910.....	5,464,597	5,551,790		1.6
1911.....	7,121,713	7,506,430		5.1
1912.....	6,612,335	6,556,500	.9	
1913.....	6,542,850	6,772,350		3.4
1914.....	7,637,113	7,718,980		1.1
1915.....	5,338,588	5,354,496		.3
1916.....	5,506,896	5,480,012	.4	
1917.....	5,237,379	5,406,350		3.0
1918.....	5,595,529	5,760,184		3.0
1919.....	5,275,096	5,462,208		3.4
20 years, 1900-1919.....	113,330,743	115,048,111		1.5
5 years, 1915-1919.....	26,953,488	27,463,160		1.8
3 years, 1917-1919.....	16,108,004	16,108,004		3.1

Note that the average deviation of the estimates from the census during the entire period of 20 years was 2.5 per cent and the average underestimate for the 20 years  $1\frac{1}{2}$  per cent; that in 1915 and 1916 it was less than one-half of 1 per cent; and for the last three years it was about 3 per cent under the final census report. These later underestimates appear to have been due partly to the practice which developed during the war of prolonging the picking season and gathering unopened bolls after the close of the picking season, called "bollies" and "snaps," which was encouraged by the relatively high price for both lint and seed. This new factor appears not to have been taken into account by the cotton reporters.

#### ENLARGED PROGRAM.

In the last annual report attention was called to the increasing demands for service since the beginning of the World War. These demands are continuing, and fall naturally into the following classes:

(1) Estimates and forecasts of consumption, production, export and import requirements, and available surplus of agricultural products, both for the United States and for foreign countries, as a basis for intelligent planting and marketing programs.

(2) Information in advance of planting time or while planting is in progress as to the acreage to be planted in different crops, in order that a prospective

surplus or deficiency may be equalized by modifying later plantings in accordance with prospective supply and demand.

(3) Crop and live-stock estimates by counties, in order that surplus or deficient production may be localized, the agricultural resources of the county shown, estimates made more accurate, and data made available for constructive work by the agricultural colleges, county agents, and farm bureaus.

(4) "Commercial" or marketable farm-surplus estimates, to show the portion of the crop to be sold and marketed, as distinguished from estimates of total production, a considerable portion of which never leaves the farms where grown.

(5) Reserve stocks on farms.

(6) New crops for which quantitative estimates are not available.

(7) Live stock and live-stock products in as much detail and with as much frequency as crops, including dairy and poultry production, which are not now estimated.

(8) Special phases of agriculture, such as farm wages and hours of farm labor; prices farmers receive for their products; prices farmers pay for equipment, machinery, and supplies; progress of farm work; quantity of binder twine required; seed requirements, supply, surplus and deficiency; number of farm tractors and other equipment; number of silos; storage capacity on farms; average distance farmers must haul products to nearest market to shipping point; kinds and quantities of fertilizers required for different crops and sections of the country; farm income and outgo; extent to which particular varieties of crops are grown and compete with each other; methods of planting, cultivating, and harvesting crops which differ in different States; utilization of different crops; and similar information bearing on crop and live-stock production on a country-wide basis.

(9) Foreign crops and live stock by counties and for the world, to show production, consumption, imports, and exports, surplus and deficiency.

(10) Information regarding the proper interpretation to be placed upon data published in tabular form.

In order that the Bureau of Crop Estimates might be equipped to meet the special demands upon it for information along the lines indicated, an enlarged program for expanding and improving the service was prepared and used as a basis for its estimates of appropriation which were submitted to the 1919-20 session of Congress. The main features of this program may be summarized as follows:

(a) With respect to crop production the bureau proposes to show for all crops; for the United States, for each State, for each county, and for each district of commercial importance—

Acreage to be planted before the planting season opens.

Seed requirements and supply.

Fertilizer requirements and supply.

Insecticide and fungicide requirements and supply.

Farm equipment and machinery requirements and supply.

Relative labor requirements and supply.

Progress of plowing and planting and other farm work.

Acreage planted—first or early crop—second or main crop.

Damage from insect pests.

Damage from plant diseases.

Damage from adverse weather conditions.

Condition.

Abandoned acreage.

Forecasts of production.

Yield per acre.

Total production.

Acreage and production of principal varieties.

Marketable surplus production.

Stocks on farms.

Grade or quality.

Sale, disposition, or utilization of crop.

Shrinkage or loss in storage.

Farm prices.

Value of crops harvested.



These data to be supplied with respect to above 70 crops, including about 10 crops for which quantitative estimates have never been made in the past, but which in the aggregate have an annual value of more than \$1,500,000,000.

Note that in this program with respect to crops provision is made for several important improvements over the present estimates:

(1) Estimates by counties, to localize crop and live-stock production data, especially marketable surplus data. This will tend to make the estimates more accurate and be of great assistance to county agents, farm bureaus, and marketing agencies, and permit of more direct dealings with counties of surplus and counties of deficient production, instead of through distant markets.

(2) Estimates of marketable surplus production. To show the portion of the crop to be marketed, shipped out of county where grown, to enter the channels of trade and become a part of the visible supply. It is this portion of the crop and not total production that influences farm and market prices, and in which all marketing agencies and consumers are directly interested.

(3) Estimates of farmers' intention to plant, in order that planting plans may be modified if it appears that too large or too small an acreage of a particular crop is about to be planted.

(4) Estimates of principal varieties, to show relative productivity and adaptability, and quantities available.

(5) Estimates of such essential factors as requirements and supply of seed, fertilizer, insecticides and fungicides, farm machinery, equipment, labor, and supplies.

(6) Abandoned acreage for all crops, to show acreage actually harvested and correct average yields per acre, and a better basis for estimating cost of production. At present no account is taken of abandoned acreage, except for winter wheat and rye, total production being estimated on basis of a reduced average yield per acre on total planted acreage.

(7) Estimates of grade or quality, to show value and quantities available for different purposes as distinguished from total quantity only.

(8) Sale, disposition, or utilization of entire crop produced, i. e., quantity fed, plowed under, spoiled, or otherwise utilized on farm, as well as quantity sold.

(9) Shrinkage or loss in storage. This is sometimes important, especially for perishables, as potatoes, apples, etc.

(b) With respect to live stock, including horses, mules, dairy cows, beef cattle, swine, sheep, goats, and poultry, the bureau proposes to show, monthly or as often as may be necessary, for the United States, for each State, and for each county—

The number of each kind on farms in January.

The number of each age classification corresponding with the census.

The number of each sex.

The number of purebred animals.

The number bred each month.

The number born.

The number bought or brought onto the farm.

The number sold.

The number slaughtered.

The number lost from diseases or other causes.

Net number remaining on farms monthly.

Number on feed.

Intended marketings.

Condition of live stock.

Feed and forage available, present and prospective, silos and silage, condition and carrying capacity of pastures and ranges.

Forecast of swine production.

Forecast of sheep production.

Forecast of meat production.

Forecast of dairy production.

Forecast of poultry production.

Forecast of wool production.

Farm prices.

Total value.

This greatly enlarged live-stock program proposes to supply information with regard to live stock in as much detail and with the same frequency as for crops. This industry represents a farm value

in excess of \$10,000,000,000. It represents in value more than half of all sales from 6,000,000 farms. Yet at the present time (1920) the Bureau of Crop Estimates has less than \$25,000 available for ascertaining the essential facts regarding this great industry. All that can be done with the present inadequate appropriation is to estimate once a year the gross number of farm animals, the number of brood sows, and losses from disease. The bureau has never attempted to estimate dairy and poultry production, which have an estimated annual value in excess of \$3,000,000,000.

(c) Foreign crop and live-stock production. The bureau proposes to collect and publish timely foreign crop and live-stock statistics, especially for competing countries of surplus production, for the information of American farmers and business men. The relation of supply and demand and resulting prices operates not only in competing counties and States but throughout the United States and all foreign countries. Great interest in foreign crop statistics has developed since the war period. World balance sheets should be prepared regularly, perhaps quarterly, showing consumption, production, net imports and exports, and net surpluses and deficiencies for all the principal countries of the world. This information will be of vital importance to farmers' organizations, the Federal and State Bureaus of Markets, and all other agencies concerned in the formulation of constructive programs of production and marketing.

(d) Analysis, interpretation, and graphic presentation of crop and live-stock statistics. It is proposed by more frequent and timely publication, by more thorough analysis, summarization and interpretation, and by graphic methods of presentation to make more strikingly and readily apparent the significance of the essential facts disclosed by text and tabular statements. This will economize the time of all who have occasion to use agricultural statistics and make them of greater practical value.

This program was approved and advocated by the Secretary of Agriculture and was specifically mentioned in the President's message to Congress. It was submitted at the last session of Congress because the bureau had been under an intensive course of preparation for the census year of 1920, when data would be available to enable it to shift from a State to a county basis of estimating; because it had developed a highly efficient skeleton organization; because during the World War every feature of the program had been demonstrated to be entirely feasible with respect to one or more crops in one or more States; because of the growing demand for such service; and because of the necessity and value of data with respect to the essential facts of production and supply on the future advancement of agriculture, and to all agencies interested in promoting agricultural production and the efficient marketing and distribution of agricultural products. To provide the organization and funds necessary to make the program effective would require an increase in the present appropriation of about \$500,000. No increase in the appropriation was granted by Congress, presumably because of its announced policy of economy and retrenchment. It was therefore necessary to hold the bureau's program of expansion and improvement of the crop-reporting and statistical service in abeyance until it can be resubmitted at the next session of Congress.

When it is considered that the maintenance of an ample supply of farm products depends upon the profitableness or unprofitableness of farming as a business, that this in turn depends upon the prices farmers receive for their products, that prices depend mainly upon relative supply, that relative supply is the equivalent of crop and

live-stock production, plus the carry-over from one season to another in this and other countries, which it is the function of the Bureau of Crop Estimates to estimate, and that the total crop and live-stock production in the United States has an aggregate value of more than \$20,000,000,000 annually, and the further fact that the increase of \$500,000 required to expand and improve the crop-reporting and statistical service represents a tax of less than one-half cent per capita, it is hoped that Congress and the public will realize that the relatively small appropriation required to put into effect a greatly enlarged program for supplying information regarding the essential facts of production and supply is an investment promising large returns and the benefits from such additional service will far outweigh the cost.

#### LOYAL SERVICE OF EMPLOYEES.

I can not close this report without referring to the loyal service of the employees of the bureau who have continued to perform their various duties through the war period and since, faithfully and efficiently, notwithstanding the fact that their salaries have remained on a prewar basis while the cost of living has more than doubled and salaries in private employment have increased correspondingly. When it is remembered that prewar salaries were in many instances much too low in comparison with positions involving similar duties and responsibilities in private employment and that the purchasing power of these salaries is now reduced one-half, one can appreciate the hardship and sacrifice involved in remaining in the Government service. While some employees of the Bureau of Crop Estimates have resigned to accept much higher salaries elsewhere, it is believed that few branches of the public service have come through the trying times of the last three years with such a small loss of personnel. This is due largely to the appreciation which employees of the Bureau of Crop Estimates have of their responsibility to the public service, their belief in the value of the crop reporting and statistical service to the public, and especially to agriculture, and their faith that the value of this service will be recognized and appreciated by the public in the not distant future, and that with such recognition will come adequate financial support for further expansion and usefulness.



## REPORT OF THE LIBRARIAN.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
OFFICE OF THE LIBRARIAN,  
*Washington, D. C., October 1, 1920.*

SIR: I have the honor to submit herewith the executive report of the library for the fiscal year ended June 30, 1920.

Respectfully,

CLARIBEL R. BARNETT,  
*Librarian.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### INTRODUCTION.

The object of the library is to assist the workers in the department, the State agricultural colleges and experiment stations, and the public in general, by making available the literature of agriculture and the related sciences and by supplying bibliographical information in regard to these subjects. It contains over 155,000 books and pamphlets and receives currently 2,700 periodicals, not including annual reports and proceedings of societies. The library catalogue contains nearly half a million cards, constituting probably the most complete bibliography of agriculture in existence.

The scope of the literature contained in the library corresponds with that of the work carried on by the department. Besides agriculture in general, it embraces botany, chemistry, zoology, entomology, forestry, agricultural economics, agricultural and commercial statistics, etc. The library of the department consists of the main library and the branch libraries connected with the various bureaus, divisions, and offices. These are all administered as a single library system for the department and the catalogue of the main library contains a record of the library resources of the whole department. In addition to its use by the department, the library maintains a system of loans by which its resources are placed at the disposal of investigators throughout the country who are engaged in serious research. This is effected by lending books to out-of-town libraries in so far as this can be done without interfering with the work of the department. In general, it may be said that its aim is to serve as the national agricultural library and to make as widely useful as possible its resources and bibliographical equipment.

From the financial statement on page 17 it will be seen that in the past four years the library appropriation has been standing still, or rather it may be more truthfully said that it has been going backward, for it is conservatively estimated that this is true of every library appropriation which has not increased by 60 per cent in the past two or three years, due to the continued and rapid increase in the price of books and periodicals and all materials and equipment. If the library book fund needs a 60 per cent increase in order even to be equal to its former purchasing power, there is need of an even greater increase in its fund for salaries to meet present living conditions. During and since the war the library has lost a large number of its trained and experienced workers because of its low salaries. Since the salaries have not yet been increased it has been impossible to fill adequately the gaps, and the close of the fiscal year found the library with a staff even more depleted and inexperienced than during the war period. If it is in future to give the service that is expected from the library of such an institution as the national Department of Agriculture, it must be adequately supported both as regards salaries and book funds, and it must also share the complete cooperation of those whom it serves in the building up of its collections. The library is a part of the working equipment of the department just as much as the laboratory and herbarium, and it is to the interest of department workers and all users of the library to see that this equipment is complete and accessible. Only with their cooperation can the library be adequately developed and satisfactorily administered. This cooperation is earnestly requested.

#### REFERENCE AND CIRCULATION DIVISION.

Miss EMMA B. HAWKS, *Assistant Librarian*, in general charge.  
Miss GERTRUDE E. UPTON, *Loan Desk Assistant*.

The reference work of the year was handicapped by the fact that it has not yet been possible to fill the position of Reference Librarian, which became vacant in March, 1919. The reference work was therefore carried by the Assistant Librarian along with other duties, with the assistance of the Chiefs of the Catalogue and Periodical Divisions. As in previous years, and perhaps to an even greater extent, use has been made of the library by workers from other departments and institutions, and by individuals both from Washington and from outside, who come to use the collections for reference purposes and for the verifying of references. Telephone inquiries from persons both inside and outside the department are also frequent. More and more the library is being called upon not simply for definite books, but also for information.

Since complete circulation statistics are not kept in all of the branch libraries and since no record of the reference use is kept in any of the libraries, the following statistics of circulation represent only approximately the use of the library.

## STATISTICS OF CIRCULATION.

*Books and periodicals charged by the main library and the bureau, division, and office libraries during the fiscal years 1919 and 1920.*

Bureau, division, or office.	Number of books charged.								Number of periodicals charged.	
	To individuals.		To main library.		To branch libraries.		Total.			
	1919	1920	1919	1920	1919	1920	1919	1920	1919	1920
Main Library <sup>1</sup> .....	12,662	11,38	-----	-----	23,795	26,363	36,457	38,301	-----	-----
Bureau of Animal Industry.....		5 426	-----	5 89	-----	-----	-----	5 515	-----	5 5,020
Animal Husbandry Division.....	(2)	(2)	68	206	(2)	(2)	(2)	(2)	5,720	5,247
Dairy Division.....	1,696	1,369	82	6 83	4	6 2	1,782	1,454	10,467	6 10,443
Biochemic, Pathological, Zoological, and other divisions.....		(2)	(2)	(2)	-----	(2)	-----	(2)	10,500	(2)
Bureau of Chemistry.....	5,700	7,567	444	481	16	13	6,160	8,061	15,501	18,792
Bureau of Crop Estimates.....	(2)	7,695	(2)	752	(2)	237	(2)	8,684	23,032	15,000
Bureau of Entomology.....	3,096	2,365	176	213	49	123	3,321	2,701	3,361	3,032
Forest Service.....	2,685	2,901	198	277	-----	-----	2,883	3,178	5,841	7,965
Bureau of Markets.....	(2)	(2)	(2)	(2)	(2)	-----	(2)	4,213	(2)	(3)
Bureau of Plant Industry.....	12,004	9,208	492	330	37	40	12,532	9,578	37,074	39,955
Bureau of Public Roads.....	528	703	88	137	6	6	1,622	846	6,693	6,977
Office of Farm Management.....	3,636	2,929	-----	-----	-----	-----	3,636	2,929	9,108	9,972
	42,007	47,101	1,548	2,568	23,907	26,784	68,393	80,460	127,497	122,403

<sup>1</sup> Statistics include circulation in all bureaus and offices for which separate statistics are not given below.

<sup>2</sup> No records kept.

<sup>3</sup> Circulation statistics for periodicals can not be kept in the Bureau of Markets because of the many corporate charges.

<sup>4</sup> For period July, 1919, to April, 1920.

<sup>5</sup> For period May to June, 1920.

The statistics of circulation given above show that the total recorded circulation of the main library and the bureau, division, and office libraries for the year was 80,460 books and pamphlets and approximately 122,000 periodicals. It is impossible to make any satisfactory comparison between the circulation this year and last year, since some of the bureau and division libraries which kept statistics last year have not kept them this year, and vice versa. The average number of books charged at the loan desk of the main library each month was 3,191, as compared with 3,038 in the previous year. The average daily circulation was 126 as compared with 120 in the previous year.

The fact that the average number of books charged at the loan desk of the main library last year was greater than in the previous year indicates that there was some increase in the use of the library, but the circulation has not yet reached its pre-war figures, as is shown by the following table, which gives the circulation statistics of the main library, by months and years, for the last 10 fiscal years, exclusive of the circulation of current periodicals:



*Circulation statistics of the main library, by months and years, for the fiscal years 1911 to 1920.*

Month.	1910-11	1911-12	1912-13	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19	1919-20
July.....	2,357	2,397	2,472	2,651	3,010	3,077	2,982	3,113	2,860	2,687
August.....	2,381	2,425	2,269	2,083	2,697	3,285	2,883	3,027	2,616	3,216
September.....	2,259	2,517	2,584	2,531	2,763	3,334	2,955	2,888	2,232	2,678
October.....	3,118	3,404	3,048	3,301	2,803	4,183	4,421	3,617	2,474	3,444
November.....	3,083	3,465	3,152	3,232	3,352	4,439	4,409	3,462	2,684	2,981
December.....	2,952	2,962	3,051	3,726	3,570	4,140	3,797	3,137	2,728	2,867
January.....	3,555	4,094	4,106	4,454	4,260	4,888	4,839	4,099	3,572	3,668
February.....	3,340	3,851	3,403	3,618	3,633	4,715	4,625	3,603	3,830	3,246
March.....	3,668	3,614	3,415	4,021	3,980	5,028	4,646	3,676	3,920	3,699
April.....	3,805	3,415	3,294	3,623	3,514	4,052	3,766	3,444	3,608	3,497
May.....	2,589	3,208	3,188	2,951	3,072	4,136	3,616	3,331	3,327	3,103
June.....	3,163	2,760	2,891	3,188	3,255	3,637	3,476	2,770	2,606	3,085
Year.....	36,250	38,112	36,933	38,879	40,953	48,914	46,339	40,447	36,457	38,301

The highest peak in the circulation of the main library, as shown in the above table, was reached in the fiscal year 1916. The circulation last year is still only 79 per cent of what it was at that time. This is due to the situation resulting from the loss of many of the department's scientific workers on account of the inability of the department to increase salaries commensurately with the increased cost of living and the higher salaries paid outside of the Government service.

#### INTERLIBRARY LOANS.

The number of books lent to libraries, institutions, and individuals outside of the city was 799, an increase of 141 as compared with the previous year. To the total number of books lent should be added 142 photostat copies and 17 typewritten copies of articles requested, making the total use outside of the city 958. The statistics of the last five years, arranged alphabetically by States, are as follows:

*Record of books lent outside of Washington during the fiscal years 1916 to 1920.*

States, etc.	Fiscal year—					States, etc.	Fiscal year—				
	1916	1917	1918	1919	1920		1916	1917	1918	1919	1920
Alabama.....		10			10	North Dakota.....	11	3	6	6	5
Arizona.....	14		7	4	4	Ohio.....	29	41	56	9	30
Arkansas.....	3	4	5	2	19	Oklahoma.....					1
California.....	50	38	13	28	43	Oregon.....	66	51	73	5	19
Colorado.....	24	16	7	5	10	Pennsylvania.....	29	19	21	10	30
Connecticut.....	2	2	5	1	7	Rhode Island.....	2	17	4	2	12
Delaware.....	10	6	17	11	50	South Carolina.....	22	27	14	2	2
Florida.....	21	15	21	17	7	South Dakota.....					3
Georgia.....	37	24	5	4	6	Tennessee.....	31	22	19	11	10
Idaho.....	5	10	6	4	8	Texas.....	11	38	8	9	4
Illinois.....	66	30	44	49	23	Utah.....	17	16	8	8	14
Indiana.....	20	13	11	4	13	Vermont.....	9	3	3	10	3
Iowa.....	80	40	52	15	22	Virginia.....	26	18	4	10	19
Kansas.....	71	38	31	41	22	Washington.....	11	2	8	21	12
Kentucky.....	7	4	8	13	15	West Virginia.....	16	8	19	19	10
Louisiana.....	10	8	21	9	5	Wisconsin.....	41	34	36	62	2
Maine.....	22	16	10	2	3	Wyoming.....	5	3		6	4
Maryland.....	28	48	30	10	21	Canada.....		1	1	3	1
Massachusetts.....	25	33	22	10	37	Hawaii.....		3	2	1	
Michigan.....	37	38	21	9	17	Porto Rico.....	43	39	28	11	14
Minnesota.....	75	50	44	63	89	Island of Guam.....				2	1
Mississippi.....		1	1	1		Alaska.....	2				1
Missouri.....	15	19	6	2	10						
Montana.....	15	19	37	17	13	Total.....	1,240	1,093	893	658	799
Nebraska.....	18	10	4		15	Photostat copies of articles.....	129	168	84	145	142
Nevada.....	3	1	1		1	Typewritten copies of articles.....	7	12	11		17
New Hampshire.....	2	8	10	7	6						
New Jersey.....	53	76	28	42	49						
New Mexico.....	9	8	6	7	6						
New York.....	127	148	103	66	65		1,376	1,273	988	803	958
North Carolina.....	17	15	7	1	6						

The number of books borrowed from other libraries in the city was 4,121, a decrease of 905 as compared with the previous year. Of the 4,121 books borrowed during the year, 3,385 were borrowed from the Library of Congress, 476 from the Surgeon General's Office, 75 from the National Museum and Smithsonian Institution, 73 from the Geological Survey, and the remaining 112 from 11 other Government libraries.

The number of books borrowed from libraries outside of the city was 39, being 31 less than the number borrowed the previous year. Of this number 9 were borrowed from the Lloyd Library, Cincinnati, 6 from the Arnold Arboretum, Jamaica Plain, 4 from the Museum of Comparative Zoology, Cambridge, and the remaining 20 from 13 other libraries.

A summary of the statistics regarding books borrowed from libraries in and out of Washington during the last five years is given in the following table. Special thanks are due to these libraries for the courtesies they have extended to the Department in the loan of their books.

*Summarized statement of books borrowed from other libraries during the fiscal years 1916 to 1920.*

Item.	1916	1917	1918	1919	1920
Largest number of books borrowed from other libraries on any day .	42	41	46	41	30
Average number of books borrowed from other libraries daily.....	23	19	15	16	13
Largest number of books borrowed from other libraries in any month.	734	623	481	613	458
Average number of books borrowed from other libraries monthly....	571	507	396	424	346
Number of books borrowed during the year from libraries outside of Washington.....	86	82	35	70	39
Number of books borrowed during the year from other libraries in Washington.....	6,774	6,010	4,717	5,026	4,160
Total number of books borrowed from other libraries in and out of Washington.....	6,860	6,092	4,752	5,096	4,199

## CATALOGUE AND ORDER DIVISION.

MISS HELEN M. THOMPSON, *Chief.*

The total number of catalogued books, pamphlets, and maps added to the library during the year was 9,593, an increase of 3,548, as compared with the catalogued accessions of the previous year. This increase was largely due to the fact that a large number of books which were ordered previous to the war were received during the year and also to the fact that more exchanges were received. More detailed statistics of the accessions of the year as compared with the previous year are given in the following table:

*Accessions to the library for the fiscal years 1916 to 1920.*

Accessions.	1916	1917	1918	1919	1920
Purchases:					
Volumes .....	1,595	1,949	1,510	1,373	1,989
Pamphlets .....	49	76	79	88	119
Maps and charts .....	13	1	4	2	6
Serials and continuations .....	274	147	97	154	187
Total .....	1,931	2,168	1,690	1,617	2,301
Gifts:					
Volumes .....	873	641	676	647	768
Pamphlets .....	397	508	642	371	580
Maps and charts .....	18	4	59	15	21
Continuations .....	4,919	4,458	3,807	2,647	4,762
Total .....	6,207	5,611	5,184	3,680	6,131
From binding periodicals and serials .....	1,612	1,178	949	748	1,161
Total .....	9,750	8,957	7,823	6,045	9,593

According to the record of accessions, the total number of books and pamphlets accessioned by the library up to July 1, 1920, was 161,704. From this number should be taken 5,910 volumes, which were discarded during the fiscal year 1915 and 652 which were discarded in the last five fiscal years, leaving a balance of 155,142.

The European book market may be said to have fairly reopened. The library has been able to buy more books this year not only from England but also from Italy and France, and has also purchased several lots from Germany. On account, however, of the fact that most of the European dealers have advanced their book prices to offset the depreciation in their money, the opportunities for the purchase of foreign desiderata have not been as favorable as it was hoped they would be.

Among the notable purchases of the year were Barbosa Rodrigues' *Sertum palmarum brasiliensium*, Blackwell's *Curious herbal*, Millais' *British diving ducks*, the long sought "*De plantis epitome utilissima*" (Francofurti ad Moenum, 1586) of Matthioli edited by Camerarius, Robert Sweet's *Geraniaceae, 1820-1830*, complete with the fifth volume, which is almost always lacking, Lanzi's *Funghi mangerecci e nocivi di Roma* (1902), and a complete set of Justus Liebig's *Annalen der chemie*. The library previously had a set from only volume 125 to date.

Among the manuscripts obtained during the year was a collection of letters addressed to Humphry Marshall by contemporary botanists and horticulturists of the latter part of the eighteenth century, including Dr. Thomas Parkes, Timothy Pickering, Sir Joseph Banks, James Vaughan, and Hippolyto da Costa.

Photostat copies of the following books of which the originals were not available for purchase were acquired by the library: Dumerey, Charles. *Bibliographie de la papeterie*. 28 p. Bruxelles, 1888: Savi, Gaetano. *Osservazione sopra i generi Phaseolus e Dolichos*. 3 parts. 1822-1825. Through Dr. R. H. True, of the Bureau of Plant Industry, photostat copies of the letters of Jared Eliot on agricultural matters were also obtained, made from the manuscript copies in the Yale University library.



In view of the fact that the library's book fund has not been increased in the last four years, it is especially gratifying that there has been a considerable increase in the number of books and periodicals which have been received by gift. To the individuals, institutions, societies, and publishers who have contributed to the library's resources, grateful acknowledgment is hereby made.

#### CATALOGUING AND CLASSIFICATION.

The record of the material catalogued and classified during the year is as follows: 2,757 volumes, 699 pamphlets, 6,110 serials and continuations, and 27 maps and charts, making a total of 9,593, an increase of 3,548 as compared with the previous year. In addition to the complete cataloguing of the above-mentioned items, author cards were made for 501 pamphlets of less importance, and 1,937 reprints. There were added to the main dictionary catalogue 21,504 cards, and 2,353 were withdrawn, making a net addition of 19,151, an increase of 388 as compared with the previous year. The main catalogue now contains approximately 430,000 cards.

The number of titles prepared during the year for printing by the Library of Congress in what is known as the "Agr" series are as follows: Cards for accessions, 817; cards for department publications, 611; total, 1,438, an increase of 270 over the previous year. The total number of titles prepared by the library since 1902, in which year the printing of the cards was begun, now amounts to 32,968.

The amount of uncatalogued material on hand July 1, 1920, was as follows: 274 volumes, 599 pamphlets, 540 continuations, and 7 maps, a decrease of 545 pieces over the previous year.

#### PERIODICAL DIVISION.

Miss LYDIA K. WILKINS, *Chief*.

The total number of different periodicals, exclusive of annuals and serials of infrequent issue, received currently by the library during the year was 2,757 titles, of which 640 were received by purchase and 2,117 by gift. The number of new periodicals added during the year was 346, whereas 82 of those listed last year are no longer received, either because they have ceased publication permanently or temporarily, or because the subscriptions have been discontinued. The net increase for the year was 264. In order to meet the demands for certain periodicals, it is necessary to purchase 207 duplicates, making the total number of periodicals purchased 847, a net increase of 17 over the previous year. The library also received 583 duplicates by gift and exchange, making the total number of periodicals handled currently during the year 3,547, an increase of 101 for the year. The following table shows the various foreign countries from which periodicals are currently received and the number received from each country, as compared with the number received in 1918, when this list was first compiled:

*Foreign countries from which periodicals are currently received.*

Country.	Titles.		Country.	Titles.	
	1918	1920		1918	1920
Africa.....	41	52	New Caledonia.....	1	1
Australia.....	32	43	New Zealand.....	8	9
Austria <sup>1</sup> .....	25	24	Norway.....	7	12
Barbados.....	2	3	Palestine.....		1
Belgium <sup>1</sup> .....	4	18	Panama.....	2	2
Bermuda.....		1	Persia.....		1
Bulgaria <sup>1</sup> .....	2	2	Philippine Islands.....	15	18
Canada.....	76	96	Portugal.....	4	6
Ceylon.....	2	2	Porto Rico.....	2	5
China.....	1	5	Rumania <sup>1</sup> .....	5	7
Cuba.....	11	10	Russia <sup>1</sup> .....	27	33
Czechoslovakia.....		2	San Lucia.....		1
Denmark.....	15	21	Scotland.....	13	13
Dominican Republic.....		4	Serbia.....		1
England.....	193	218	South America:		
Fiji Islands.....		1	Argentina.....	20	32
Finland <sup>1</sup> .....	1	2	Bolivia.....	1	1
France.....	122	136	Brazil.....	20	27
French Indo-China.....	1	2	British Guiana.....	2	1
Germany <sup>1</sup> .....	258	276	Chile.....	5	5
Greece.....	1	1	Colombia.....	5	6
Guatemala.....		1	Dutch Guiana.....	2	2
Hawaii.....	3	6	Ecuador.....		3
Honduras.....	2	2	Paraguay.....	1	1
Hungary <sup>1</sup> .....	12	12	Peru.....	8	8
Iceland.....	2	2	Uruguay.....	5	6
India.....	38	41	Venezuela.....	1	2
Ireland.....	10	11	Spain.....	21	22
Italy.....	76	88	Straits Settlements.....	2	2
Jamaica.....	2	2	Sumatra.....	2	1
Japan.....	21	36	Sweden.....	21	25
Java.....	16	22	Switzerland.....	22	25
Mesopotamia.....	1	1	Trinidad.....	3	3
Mexico.....	18	23			
Netherlands.....	23	28	Total.....	1,236	1,479

<sup>1</sup> Many have not been received regularly since the war.

In addition to the 2,757 current periodicals appearing not less than four times a year, the library received 4,842 serials of less frequent issue, such as annual reports, proceedings, and transactions published by institutions and societies, an increase of 1,288 as compared with the previous year. This increase is due largely to the fact that many more exchanges were received during the year from foreign countries.

There is a continued demand for a printed title and subject list of the periodicals currently received by the library. Such a list was published in 1910 and there has been no revision. Since that date the number of periodicals received by the library has increased by 1,182. It is hoped that a new edition may be published during the coming year. There is also a demand for a new edition of the complete catalogue of periodicals and serials contained in the library, the first edition of which was published 20 years ago, in 1901, as Bulletin 37. The library has the data for a new edition, but funds for its printing have not been available.

**DUPLICATES.**

While the library received as many duplicates during the year as in previous years, it was not possible, on account of lack of assistance, to devote much time to the work of listing and disposing of them, but about 15 mail bags of publications selected by the libraries of the State agricultural colleges and experiment stations have been distributed during the year. These duplicates are for the most part periodicals, official publications, and publications of societies and

institutions which are sent to various offices of the department and turned over to the library. Considerable time was spent in making a separate list of the large number of duplicates of the International Institute of Agriculture, Rome, which had been received in this way. This list was sent to 23 institutions and about one-third of the duplicates were selected. The library has great need of an assistant whose full time can be devoted to the work of listing and disposing of the duplicates in order to keep the work up to date, especially as there is little space available for storage.

#### MAILING LISTS AND DISTRIBUTION OF DEPARTMENT PUBLICATIONS.

There were 1,758 orders issued on the Division of Publications for the mailing of department publications which were requested by foreign institutions and officials and by societies and private individuals from which publications are received in exchange. This was an increase of 164 over the previous year, due to the fact that exchange arrangements which were interrupted during the war are now gradually being renewed. Considerable time was spent in the revision of the various mailing lists, particularly the foreign list to which is sent the Monthly List of Publications. The work in connection with the distribution of department publications to foreign countries and to libraries in the United States is appropriately assigned to the library because of its close connection with the work of obtaining exchanges.

#### BINDING DIVISION.

Miss IDA B. SWART, *Chief*.

During the year 1,866 volumes were sent to the bindery, a decrease of 145 as compared with the previous year. In addition to the number of books permanently bound, approximately 1,000 volumes were laced into temporary binders and 984 pamphlets were stapled into temporary binders. The binding work has suffered greatly, owing in part to lack of assistance for the work and in part to the lack of funds for binding. The second assistant in the binding work resigned in January, and it has not yet been possible to fill the position. The following table shows the number of books which have been bound during the last ten years and the number of periodicals currently received.

*Books bound and periodicals currently received.*

Item.	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
Periodicals received currently...	1,978	1,948	2,035	2,128	2,337	2,280	2,219	2,433	2,493	2,757
Volumes sent to the bindery...	3,274	3,930	3,530	3,362	3,832	3,363	4,064	1,674	2,019	1,866

Comparison of the figures given above will show that whereas the number of current periodicals received has increased from 1,978 to 2,757, the number of volumes sent to the bindery has decreased. No more convincing argument need be given for the urgent need for a greatly increased allotment for library binding if the current periodicals and other unbound publications are to be adequately cared for and made available for convenient use. In order to meet the library's present needs, the number of books and periodicals bound annually should not be less than 5,000 volumes.



## BIBLIOGRAPHY.

The amount of bibliographical work done during the year was notably below that of previous years, both in the main library and in the bureau and division libraries. This was due principally to depleted staffs, making it difficult to do more than the regular routine work. In the main library the principal bibliographical work was done in connection with correspondence. The library receives numerous requests for lists of references on various scientific and agricultural subjects connected with the work of the department, and also requests for the verification of references, including the straightening out of bibliographical tangles.

The librarian of the Bureau of Entomology devoted a very considerable part of her time during the year to the preparation of the Index to the Literature of American Economic Entomology, 1915 to 1919, inclusive. This extensive index, comprising some 50,000 references, which was begun in January, 1919, was completed in April, 1920, and is now in the hands of a committee of the American Association of Economic Entomologists awaiting funds for publication.

The library of the Bureau of Entomology has also continued the card index to publications of the Bureau, 51 of these having been indexed during the year, as well as several other publications by other bureaus containing references to entomology, and has continued the preparation of author cards for articles on entomology by members of the Bureau appearing in nondepartmental publications. Brief lists of new books of interest to the Bureau of Entomology have been prepared monthly for the Bureau News Letter.

In the Office of Farm Management the following lists of references were prepared by the library: Selected list of references on the cost of producing field crops; Selected list of references on the cost of producing hay; Selected list of references on the cost of producing truck crops; Selected list of references on the cost of potato production; References on labor distribution. The following lists have been revised and brought up to date: Farm management surveys issued by the agricultural experiment stations; Articles relating to farm management that have appeared in the agricultural press; List of books on farm management; State and station publications relating to farm management; Publications of the United States Department of Agriculture relating to farm management.

The American Forestry Magazine discontinued last fall the printing of the monthly list of current literature indexed in the Forest Service library, owing to a change of policy in its publication. The list is now mimeographed each month and circulated to all district foresters, forest supervisors, experiment stations, and the Forest Products Laboratory, as well as to interested persons outside of the Service.

A number of miscellaneous reference lists on various subjects bearing upon the work of the Bureau of Markets have been compiled by the library of the Bureau during the year. Among these may be mentioned an annotated bibliography of official publications relating to the acts administered by the Bureau of Markets and for its development. The library has also revised and made available for distribution the mimeographed lists of the publications and of the periodical market reports of the Bureau of Markets.

In the Bureau of Plant Industry bibliographies in 128 manuscripts, comprising 2,125 references, were verified and edited. A check list of the State experiment station publications on plant pathology, which is to be issued in mimeographed form as a number of the "Bibliographical Contributions" of the library of the Department of Agriculture, is in process of preparation, as is also a check list of the publications of the Bureau of Plant Industry, and all offices and divisions which were combined to form the Bureau in 1901. The absence of the librarian for the larger part of the year delayed the completion of these two lists, but it is hoped that they will both be completed and be ready for mimeographing in the near future.

The Library of the Bureau of Plant Industry, in cooperation with Miss A. C. Atwood, has continued to prepare the index to the "Literature of plant diseases" which is published monthly in "Phytopathology" and has also continued the preparation of the mimeographed list of "Current author entries" for articles in current periodicals of interest to the Bureau.

It seems fitting to mention here the important bibliographical projects carried on by Miss Marjorie F. Warner and Miss Alice C. Atwood, bibliographical assistants of the Office of Economic and Systematic Botany of the Bureau of Plant Industry, as their work is closely allied with the Bureau library. Their work on the index of botanical illustrations, the bibliography of horticulture, and the union catalogue of botanical literature, which have been described in previous reports, was continued during the year. The last of March a list of abbreviations of works to be included in the new edition of Pritzel's *Icones* was received from Dr. Otto Stapf, of Kew, editor for the Royal Horticultural Society, and a large amount of time was spent in going over the list with reference to possible omissions and desirable additions. The results of this cooperative work are still in the making.

Another piece of verification work requiring much time was the correction of the errors in the "Bibliography of take-all" by F. L. Stevens in the Illinois Laboratory of Natural History (Bulletin vol. 13, Art. IX, Oct., 1919). These corrections have not been published, but are available in typewritten form to libraries or scientific workers that may wish them. An article by Miss Atwood on the "Errors in Lindau's Thesaurus and Saccardo's Sylloge" was published in "Mycologia" vol. 12, p. 169-171, May, 1920. Miss Warner's paper on the "Bibliographical opportunities in horticulture," which was read before the Agricultural Libraries section of the American Library Association in June, 1919, was published in the Proceedings of the Association for 1919, p. 178-184, and also in the Library Journal, under the title, "The literature of horticulture," vol. 44, p. 766-776, December, 1919.

The bibliographical work of the State Relations Service library described in previous reports was continued along the same lines during the year.

In the spring of 1920 the library was offered the use of a page in each number of the "Agricultural Index" to be called "Agricultural Library Notes." These notes will be principally bibliographical in character. The first number, for which contributions were made by the main library and the bureau libraries,

appeared in the June, 1920, issue. It is expected that contributions will be received also from other libraries and that it will thus become a medium of communication among agricultural libraries for notes of common interest.

### PUBLICATIONS.

The only printed publication that it was possible for the library to issue during the year was the report of the library for the fiscal year 1919, a pamphlet of 16 pages. As in the case of the binding this was due in part to the lack of any funds for printing. The library continues to feel the need for some medium for making better known to the department workers and to the scientific workers in other institutions the new accessions to the library and its great resources in general. It is hoped that in the near future it will be possible to publish regularly at least a brief list of its most important accessions and also a handbook of the library and a catalogue of all its periodicals and other serials.

### LIBRARY STAFF.

The number of employees carried on the library staff at the close of the fiscal year was 32, with 3 of the lower positions vacant. Of the total number on the roll, 5 were temporary assistants, it not having been possible to fill the positions permanently on account of the salaries the library was obliged to offer. The number employed by the bureau, division, and office libraries was 42. Of the total number employed in the main library and the bureau, division, and office libraries, 17 are men and 57 are women, divided as follows: Sixteen in administrative work, including the librarian of the department, the heads of divisions in the main library, and the librarians of the bureaus and offices; 28 library assistants; 14 clerical assistants; 13 messengers; 3 charwomen.

In the main library there were in all 16 resignations during the year. Of this number, 7 were library assistants, 5 were clerical assistants, and 4 were messengers. Out of a staff of 32 on June 30, 1920, there were only 21 who were on the library rolls at the beginning of the fiscal year. Out of 21 only 14 had been in the library two years and only 11 had been in the library three or more years.

In continuance of the library's policy of offering temporary appointments whenever possible to librarians or assistants connected with the State agricultural colleges and experiment station libraries who wish to have experience in this library, two more were added during the year to the list of such appointments, the assistant librarian of the Virginia Polytechnic Institute having been appointed for the months of June and July, 1920, and the librarian of the South Carolina Agricultural Experiment Station for the month of July, 1920.

Several important changes in the personnel of the libraries of the bureaus have been made during the year. The librarian of the States Relations Service, Miss E. Lucy Ogden, resigned January 16, 1920, and was succeeded by Miss Martha L. Gericke; the librarian of the Bureau of Chemistry, Miss Anne E. Draper, resigned May 19, 1920, and was succeeded by Miss Louise Duvall, formerly assistant librarian of the bureau. The latter position was filled by the transfer of Miss Minerva G. Beckwith, assistant chief of the periodical division



of the main library. Miss M. E. Griffith, assistant librarian of the Bureau of Markets, resigned September 15, 1919; Miss Margaret Doonan, librarian of the dairy division, resigned January 11, 1920, and was succeeded by Miss Carrie B. Sherfy. On the reorganization of the Bureau of Animal Industry Library in May, 1920, Miss Sherfy was made librarian of the Bureau and Miss M. F. Thompson, of the Catalogue Division in the main library, was made associate librarian. In addition, the librarians of two other bureaus resigned at the end of the fiscal year, their resignations being effective July 1, namely, Miss Caroline B. Sherman, librarian of the Bureau of Markets, who was succeeded by Miss Mary G. Lacy, and Miss Cora L. Feldkamp, librarian of the Office of Farm Management.

The total number of resignations in the bureau libraries during the year was eight. Of this number, seven were librarians and library assistants and one was a translator.

Miss Eunice R. Oberly, the Librarian of the Bureau of Plant Industry, and Miss Margaret Doonan, the Librarian of the Dairy Division, who were detailed on June 12, 1919, to the Congressional Committee on the Reclassification of Salaries, to assist in the reclassification of library salaries, remained with the commission until January 11, 1920.

The Librarian of the Department, with Miss Eunice R. Oberly and Miss Alice C. Atwood, of the Bureau of Plant Industry Library, served during the year on the Library Advisory Wage Committee of the Joint Congressional Commission on the Reclassification of Salaries. Miss Caroline B. Sherman, Librarian of the Bureau of Markets, spent two weeks in November as a field agent of the commission in visiting certain public, university, and business libraries in New York, Boston, and Albany, for the purpose of collecting library wage data.

Library staff meetings have been held each month from October, 1919, to June, 1920. The principal subjects of the various meetings were as follows: reports by various members of the staff on changes and developments in the work of the department since the armistice; a talk by Miss C. B. Sherman on her visit to various libraries for the purpose of collecting wage data for the library service; notes on New York and Boston libraries, by Miss M. F. Warner; some middle western libraries, by Miss Mary G. Lacy; a talk by Miss Mary E. Hazeltine, director of the Wisconsin Library School; the value and interest of biographical indexing, by Dr. T. S. Palmer, Bureau of Biological Survey; a report on the New York meeting of the Special Libraries Association; special libraries the world over, by Prof. Ralph L. Power, Librarian of the College of Business Administration, Boston University.

The Librarian and the Chief of the Periodical Division of the main library, and the librarians of the Bureau of Chemistry and the Office of Farm Management, attended the meeting of the Special Libraries Association in New York in April, 1920. The Librarian has continued to serve during the year as Associate Editor of "Special Libraries," representing agricultural and Government libraries.

In concluding this portion of the report, the Library wishes to express appreciation of the way in which the members of the staff have responded to the demands made upon them in spite of difficulties and vicissitudes in carrying on the work.

## BUREAU, DIVISION, AND OFFICE LIBRARIES.

It is regretted that it is not possible to give in detail the reports of the librarians of the various libraries on their work of the year. The following statistics, extracts, and summaries are taken from their reports. An account of their bibliographical and other activities is given in the preceding pages.

*Books, pamphlets, and periodicals in bureau, division, and office libraries.<sup>1</sup>*

Bureau or office.	Librarian in charge.	Number employed.	Number of books.	Number of pamphlets.	Number of periodicals currently received.	Number of registered borrowers.	Number of registered borrowers to whom periodicals are circulated.
Bureau of Animal Industry: <sup>2</sup>	Miss Carrie B. Sherfy...	3	.....	.....	500	128	108
Animal Husbandry Division.	Miss Jessie Urner.....	1	1,162	4,450	155	28	28
Bureau of Biological Survey.	Mr. W. H. Cheesman <sup>5</sup> ...	2	1,060	4,950	92	38	10
Bureau of Chemistry.....	Miss Louise Duvall.....	4	7,263	.....	397	256	111
Bureau of Crop Estimates.	Mrs. Ellen H. Painter...	2	<sup>4</sup> 18,000	.....	746	56	19
Bureau of Entomology.....	Miss Mabel Colcord.....	2	7,379	9,150	256	216	15
Bureau of Markets.....	Miss Caroline B. Sherman. <sup>3</sup>	8	3,910	1,000	523	<sup>4</sup> 147	<sup>4</sup> 45
Bureau of Plant Industry.	Miss Eunice R. Oberly..	9	<sup>4</sup> 4,000	<sup>4</sup> 1,000	920	392	151
Bureau of Public Roads..	Mr. M. A. Hays.....	1	<sup>4</sup> 1,000	<sup>4</sup> 4,000	147	.....	40
Forest Service.....	Miss Helen E. Stockbridge.	1	<sup>3</sup> 21,619	.....	81	114	.....
Office of Farm Management.	Miss Cora L. Feldkamp.	2	<sup>3</sup> 9,050	.....	320	111	57
Office of the Solicitor....	Mr. F. B. Scott.....	1	<sup>4</sup> 2,000	.....	.....	.....	.....
States Relations Service..	Miss Martha L. Gericke.	8	<sup>4</sup> 2,815	6,281	735	131	64

<sup>1</sup> All books for the use of the Department in Washington, including those filed in the bureaus, are purchased and catalogued by the main library. No bureau library is maintained by the Bureau of Soils. The Weather Bureau library is administered separately, with the exception that the books and periodicals are purchased from the appropriation for the Library of the Department, the sum of \$1,000 being set aside each year for this purpose. The report of the Weather Bureau library is contained in the report of the Weather Bureau.

<sup>2</sup> Organized Feb. 14, 1920.

<sup>3</sup> Books and periodicals.

<sup>4</sup> Approximate figures.

<sup>5</sup> Editor and librarian.

It will be noted that the Dairy Division library does not this year appear in the above table, owing to a reorganization during the past year of the library activities of the Bureau of Animal Industry. On February 14, 1920, authority was given to Miss Sherfy, the librarian of the Dairy Division, to merge the Dairy Division library with the library work of the other offices of the Bureau with the exception of that of the Animal Husbandry Division, which is in the uptown offices at some distance from the main offices and laboratories of the Bureau. Since, however, no assistant was available to help in the reorganization, the change did not virtually go into effect until May 1, 1920, when Miss M. F. Thompson, of the main library, was transferred to the Bureau of Animal Industry as associate librarian. Arrangements were immediately made to merge all the work in connection with the circulation of periodicals in the Bureau, aside from the Animal Husbandry Division, but on account of lack of space in which to bring together in a central place all the book collections

in the Bureau, the catalogues and other equipment, it is still necessary to carry on the work in the locations of the former separate libraries, namely, room 247, second floor, and room 425, fourth floor of laboratory A. The reorganization of the work will undoubtedly give the Bureau better library service, but until all the work can be brought together in one convenient location and another assistant appointed it will be impossible to give the new arrangement a fair trial. Some years ago the Bureau started a card index of veterinary literature. This grew rapidly for a few years, but recently its growth has been slow on account of lack of assistance to keep it fully up to date. It now comprises approximately 180,000 cards. The possibilities for usefulness to the Bureau and to scientific workers throughout the country are large, and it is hoped that sufficient assistance will be available to revise the catalogue and to bring up to date certain subjects which have been somewhat neglected.

There was no outstanding feature in the work of the library of the Bureau of Biological Survey other than a further condensation of space available for its accommodation, about 500 books have been returned to the main library for filing, bringing down the collection to about the minimum possible. Since the Bureau is in close proximity to the main library, it being on the floor above, the library duties connected with this branch library are somewhat incidental and consume a small part of the time of the one in charge, his principal duties being editorial in character.

The libraries of the Bureau of Crop Estimates and the Bureau of Entomology both call attention to the crowded condition of their shelves, which has made it necessary for them to send more of their collections to the main library for filing. Still further and more radical reductions in their collections will be necessary unless more space is made available for these libraries.

A change in the location of the Office of Farm Management library took place during the year, the office having been moved from 224 Twelfth Street, SW., to the corner of Fourteenth and B Streets, SW. The change was beneficial, since the library now has more space and more light. There is a further advantage in the fact that the building in which it is located is next to the one in which the main library is located, thus making it more accessible.

The work of the Forest Service library was carried on along the lines of previous years and no new work was begun. The records in connection with the purchase of books for the "field libraries" of the Forest Service, that is, libraries connected with offices, stations, and laboratories of the service outside of Washington, are handled by the librarian of the Service. There are 162 of these field libraries. Of these, 149 are on National Forests, 6 in the District Foresters' offices, 6 at the Experiment Stations, and one at the Forest Products Laboratory, Madison. About \$2,000 was spent by the Service last year for these libraries, aside from the Forest Products Laboratory, which purchases its own books.

The records connected with the purchase of books and periodicals for the field libraries of other bureaus are also for the most part kept by the bureau libraries. Varying amounts are spent by each bureau for such purposes.

The outstanding feature of the Bureau of Markets library during the year was the clear differentiation of the library and the editorial



work. On the resignation of the assistant librarian and assistant editor on September 15, it was decided to have thereafter one chief assistant for library work and one chief assistant for editorial work and to separate the lines still further as much as compatible with economy and success. At the close of the fiscal year it was decided to transfer the editorial work entirely to the Office of Market Information and to confine the work of the Bureau library more strictly to regular library work. With the change is involved the transfer of the librarian, Miss C. B. Sherman, who has had charge of the editorial work, to the Office of Market Information, where she will continue to have charge of the editorial work. As previously noted Miss Mary G. Lacy was appointed in her place as librarian of the Bureau.

There was a greater change last year in the personnel of the Bureau librarians than in any previous year. The change of the librarian of the Bureau of Markets to another branch of the Bureau and the resignations of the librarians of the States Relation Service, the Bureau of Chemistry, the Dairy Division, and the Office of Farm Management have been a severe loss to the library service of the department.

#### FINANCIAL STATEMENT.

A comparison of the receipts and expenditures of the library for the last 10 years is given in the table on the following page.

For the years 1916 to 1920 there are still many outstanding orders which, when filled, will be paid for from the appropriations for those years

## Financial statement, fiscal years 1911 to 1920.

## RECEIPTS.

	Fiscal year.									
	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
Source:										
Library appropriation.....	\$35,320.00	\$40,500.00	\$41,280.00	\$43,520.00	\$45,360.00	\$46,020.00	\$49,520.00	\$50,160.00	\$50,160.00	\$50,160.00
From department printing and binding fund.....	12,420.72	12,813.95	13,843.31	11,345.84	10,190.62	9,662.12	8,707.52	12,068.38	5,358.21	9,210.70
Total.....	47,740.72	53,313.95	55,123.31	54,865.84	55,550.62	55,682.12	58,227.52	62,228.38	55,518.21	59,370.70

## EXPENDITURES.

Books and serials.....	8,832.77	6,914.48	6,794.73	9,083.69	8,304.60	8,519.54	8,875.38	7,103.42	6,911.99	8,532.18
Periodicals.....	3,192.06	3,706.67	3,625.42	4,233.41	3,586.17	3,973.96	4,086.97	4,212.08	6,077.36	4,227.63
Maps.....	.25	175.00	.....	47.50	.40	.....	215.00	40.88	.70	62.04
Photographs.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Index cards.....	224.44	146.89	215.86	174.03	194.88	169.59	139.07	78.86	85.25	112.23
Furniture, shelving, and miscellaneous equipment.....	1,055.96	966.12	2,635.99	769.37	3,148.23	866.85	552.26	765.58	604.04	293.16
Traveling expenses.....	30.50	97.98	38.45	.....	.....	31.20	.....	179.44	179.44	49.42
Freight, express, and drayage.....	.....	.....	313.27	323.42	350.00	428.41	10.62	16.54	37.75	80.51
Supplies and repairs.....	304.97	164.02	27,100.27	28,377.29	29,585.50	31,278.06	469.24	981.33	609.01	523.70
Salaries (main library).....	21,576.16	27,848.17	40,723.99	43,008.71	45,169.78	45,267.51	47,364.07	46,560.94	31,440.95	31,432.85
.....	35,217.11	40,019.33	40,723.99	43,008.71	45,169.78	45,267.51	47,364.07	46,560.94	45,946.49	45,313.72
Printing.....	3,676.34	3,307.54	4,084.21	1,892.25	1,895.47	1,806.79	1,727.17	1,576.78	652.75	348.56
Binding.....	8,744.38	9,506.41	9,759.10	9,453.59	8,295.15	7,855.33	6,980.35	10,491.60	4,705.46	8,862.14
.....	12,420.72	12,813.95	13,843.31	11,345.84	10,190.62	9,662.12	8,707.52	12,068.38	5,358.21	9,210.70
Total.....	47,637.83	52,833.28	54,567.30	54,354.55	55,360.40	54,929.73	56,071.59	58,629.24	51,304.70	54,524.42

An itemized statement of the amounts spent for printing and binding for the fiscal years 1919 and 1920 is given in the following table:

*Expenditures for library printing and binding for the fiscal years 1919 and 1920.*

Item.	1919	1920
Regular binding.....	\$2,734.23	\$8,255.80
Binders.....	1,641.23	606.84
Pamphlet boxes.....	330.00	.....
Forms.....	247.82	259.38
Publications.....	400.36	84.36
Miscellaneous.....	4.57	4.88
Total.....	5,358.21	9,210.76



## REPORT OF THE DIRECTOR OF THE STATES RELATIONS SERVICE.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
STATES RELATIONS SERVICE,  
*Washington, D. C., September 23, 1920.*

SIR: I have the honor to present herewith the report of the States Relations Service for the fiscal year ended June 30, 1920.

Respectfully,

A. C. TRUE, *Director.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### INTRODUCTION.

#### AMOUNT AND SOURCE OF FUNDS ADMINISTERED.

The year ended June 30, 1920, was a period of transition from a war to a peace basis in the work of the States Relations Service. The war emergency fund of \$6,100,000 for extension work terminated with the fiscal year ended June 30, 1919, but the settlement of business growing out of the use of that fund was a large item in the fiscal year 1920. In lieu of the emergency fund Congress appropriated \$1,500,000 to the Department of Agriculture to be expended under the terms of the extension act of May 8, 1914, and continued appropriations for farmers' cooperative demonstration work amounting to \$1,396,320. The other funds appropriated for the work of the service amounted to \$569,000. In addition, Federal funds amounting to \$1,440,000 were appropriated for the agricultural experiment stations and \$3,080,000 for cooperative extension work. State funds amounting to \$4,100,000 were used as an offset to the Federal funds for extension work as required by law. This service, therefore, had administrative and advisory relations in the expenditure of \$12,085,320, of which \$7,985,320 were Federal funds. In addition the agricultural colleges and experiment stations used in experimental and extension enterprises \$7,200,000, derived from sources within the States.

#### CHANGES IN PERSONNEL.

In the fiscal year 1919-20 the force carried on the rolls of the States Relations Service aggregated about 5,700, as compared with 7,000 the previous year. The number of counties having agricultural extension agents declined from over 2,400 to about 2,000 and the number having home-demonstration agents from about 1,700 to

about 800. These reductions were due in part to the withdrawal of the war emergency funds, and also to increased expense of maintaining competent extension agents and the difficulty in finding well-trained men and women willing to undertake the work for the compensation which it was practicable to give. Besides the reductions, numerous changes occurred in the personnel of the extension forces, making a very expensive and unsatisfactory overturn.

To meet the changed conditions of the work the force employed in the Washington office and as agents supervising and aiding the work in the field was reduced from 436 employees on June 30, 1919, to 290 on June 30, 1920. During the year nearly 100 employees were lost through resignation or transfer, in addition to the temporary employees who were to be dropped. Fully 95 per cent of those who left the service did so either to accept higher salaries at the time or because they considered their chances of advancement better elsewhere. A considerable number of the most competent technical workers left to receive greatly increased salaries.

#### CONSOLIDATION OF OFFICE BUSINESS.

The bringing into one building of all the Washington force except that of the Office of Home Economics has made it possible to consolidate much of the routine business in the central office and to introduce a number of economies in the transaction of business.

#### WORK IN AID OF THE EXPERIMENT STATIONS.

The Office of Experiment Stations has aided the State stations as far as possible in their efforts to restore their research work, interrupted or weakened by conditions growing out of the war, and to make the most of their resources, now very inadequate because of the greatly increased expense of conducting such work. The experiment stations maintained by the service in Alaska and the insular possessions have suffered from the loss of investigators and high costs, but have steadily pursued their work and obtained useful results. Special attention has been given to the reorganization and development of the station in the Virgin Islands.

#### DEVELOPMENT OF THE EXTENSION WORK.

The northern and southern extension offices have concentrated their efforts more largely on aiding the State extension forces in the settlement of the administrative problems relating to the strengthening and further development of the cooperative extension work, laying special emphasis on the organization of the county work so that it may represent the real requirements of farming people and have their intelligent cooperation and support. Increased attention has been given to the development of extension methods dealing with the economic problems of agriculture. Special studies have been made of the needs of the farm women in order that the home demonstration work may be made as helpful as possible in lightening their burdens and making their life on farms more satisfactory and attractive. Efforts have been made to perfect the organization of the boys' and girls' club work as an organic part of a permanent system of extension

work dealing with the practical operations of the farm and the farm home. Studies of the organization and work of the extension specialists have also been made with a view to a more perfect coordination of their work with that of the county men and women agents. Much attention has been given to problems connected with the development of demonstration work among the negro people on the farms. This work is already conducted on a substantial basis with very useful results and constitutes a bond of helpful relations between the extension agents and farming people of both races.

#### PROGRESS IN INVESTIGATION IN HOME ECONOMICS.

The Office of Home Economics has tried to meet as far as possible the greatly increased demand for new information on the problems of the household, growing out of the larger development of instruction and extension work in home economics and the increased burdens on family incomes with reference to food, clothing, household equipment, and operation. The limited funds of this office restrict its research to a few problems and even with those it is difficult to conduct its experimental inquiries on a scale sufficient to secure definite and satisfactory results without undue prolongation of the work. The information accumulated by this office from various sources is disseminated as rapidly as possible through the department's agencies which reach the schools, extension forces, and the public generally. But this very useful service is necessarily to a considerable extent at the expense of the research work.

#### AID TO VOCATIONAL EDUCATION IN AGRICULTURE.

The interest in vocational education through the secondary and elementary schools continues to grow rapidly throughout the country. This has put greatly increased burdens on the limited number of well-trained teachers and has brought into the work many teachers poorly equipped for this kind of service. This has brought on the States Relations Service, through its cooperation with the Federal Board for Vocational Education, the State agricultural colleges, and State departments of education, an increased demand for up-to-date subject matter and illustrative material on agricultural topics in form for immediate use in the schools. It is believed that no work of the States Relations Service is more useful than what it is doing to aid teachers in the instruction of youth who are to spend their lives on our farms.

#### DUTIES AND ORGANIZATION OF THE SERVICE.

In general, the States Relations Service represents the Secretary of Agriculture in his relations with the State agricultural colleges and experiment stations under the acts of Congress granting funds to these institutions for agricultural experiment stations and cooperative extension work in agriculture and home economics, and in carrying out the provisions of the acts of Congress making appropriations to the Department of Agriculture for farmers' cooperative demonstration work; investigations relating to agricultural schools, farmers' institutes, and home economics; and the maintenance of agri-



cultural experiment stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands.

The service includes the following offices: (1) Office of the Director, which deals with the general business and administration of the service and the work relating to agricultural instruction and farmers' institutes; (2) Office of Experiment Stations, which deals with the work and expenditures of the State and insular experiment stations; (3) Office of Extension Work in the South, which has charge of cooperative extension work in 15 Southern States; (4) Office of Extension Work in the North and West, which has charge of cooperative extension work in 33 Northern and Western States; and (5) Office of Home Economics, which deals with questions of food, clothing, and household equipment and management.

#### OFFICE OF THE DIRECTOR.

The general administrative business of the States Relations Service has been considerably modified during the past year by concentration in the central offices of a considerable amount of routine business hitherto conducted by other branches of the service and by the simplification of accounting work through confining the direct contributions to the extension work in the States chiefly to payments on the salaries of the extension agents. The great extent of the extension work and the shifting character of the cooperative extension forces, owing largely to the withdrawal of agents to engage in more profitable enterprises, together with the great variety of conditions connected with the State and county contributions to the extension work, necessitate a very large amount of routine administrative business. To this has been added much new business growing out of the enlargement of the work connected with the insular experiment stations, investigations in home economics, and the preparation and dissemination of publications and illustrative material for the extension forces, farmers' institutes, and schools, and for the use of the department's Division of Publications in its relations with the agricultural and general press throughout the country.

#### EDITORIAL DIVISION.

W. H. BEAL, *Chief.*

The work of this division included, as heretofore, the business connected with (1) the editing of all publications of the service except Experiment Station Record, and (2) the collection, preparation, and distribution of illustrative material for service use. During the latter half of the year the duplicating work of the service, which had previously been divided into three separate units, was consolidated and reorganized as a section of the Editorial Division.

Owing to shortage of funds for printing, the number and volume of publications printed for the service during the year were very much smaller than for the previous year. The publications issued included 39 documents, aggregating 2,959 pages, as compared with 64 documents, aggregating 3,997 pages, of the previous year. There were issued 20 numbers of Experiment Station Record, 3 administrative reports, 3 farmers' bulletins, 9 department circulars, 2 publica-

tions of the insular experiment stations, and 2 miscellaneous documents. This list includes no technical bulletins dealing with the investigational work of the service, such as that of agricultural education and home economics, and only 2 publications dealing with the work of the insular stations, whereas during the previous year there were 6 of the former and 10 of the latter. The shortage of printing funds made it necessary either to hold up such publications or to seek other means of publishing them. The number of such publications prepared for printing was fully as large as during the previous year. The usual job printing and binding required in connection with the current work of the service was done.

The Editorial Division continued to cooperate with the Division of Publications of the department through its Office of Information in assembling and preparing informational and illustrative material of wide general interest relating to the work of the service.

**ILLUSTRATIONS SECTION.**—The work of this section developed during the year, especially along the following lines: (1) Cooperating with other divisions of the service and with the Division of Publications in securing photographs illustrating work of the service for use in publications and publicity matter and for the preparation of lantern slides and other instructional material; (2) filing, classifying, and cataloguing the illustrative material of the service for ready reference and use; (3) preparation and distribution of sets of lantern slides on various subjects and of charts, diagrams, and drawings in colors for extension and other educational uses; (4) selection and arrangement of exhibit material illustrating the work of the service; (5) cooperating with the Division of Publications in the preparation of motion pictures of the work of the service; (6) furnishing information regarding photographic work for educational purposes and the selection and use of illustrative material by service employees and other cooperating agencies.

Through field trips to 14 States and through other means, about 1,500 new photographs of special educational value were added to the collection during the year. This collection now contains 12,554 photographs, 10,188 of which are mounted, classified, and catalogued for convenient reference. The section cooperated in the preparation of sets of slides with descriptive legends on the following subjects: Beautification of the farmstead, demonstrations with the hot school lunch, good and bad extension photography, home-demonstration work with poultry, labor-saving methods and equipment in the home, and winter wheat production. Approximately 1,400 sets of about 50 slides each were distributed during the year for different divisions of the service. The total number of charts and drawings made was 200.

Special attention continued to be given to the coloring of lantern slides and bromide enlargements. Of the former 2,685, and of the latter 130, were colored with unusual care and fidelity to nature.

Methods of handling exhibit material were further developed, the section cooperating with the Office of Exhibits of the Division of Publications in supplying maps, models, and picture panels for the general department exhibits. Direct assistance was also given to cooperating institutions in preparing and installing exhibits of cooperative extension work.



The section cooperated with the Division of Publications in preparing two motion pictures entitled Apples and the County Agent and Club Champions at Camp Vail.

A mimeographed circular on Suggestions Regarding the Classification of Photographs of Agricultural Subjects for the Use of Extension Workers was prepared and sent to employees and cooperators of the service during the year, and at the request of the Virginia and Tennessee extension services a representative of the section attended State conferences in each State to discuss methods of securing and using photographs in extension and other educational work in agriculture and home economics.

DUPLICATING SECTION.—The duplicating work of the service was organized as a section of the Editorial Division, March 15, 1920. The consolidation thus put into effect has resulted in a material increase in efficiency and economy in this work.

#### INVESTIGATION ON AGRICULTURAL INSTRUCTION IN SCHOOLS.

ERWIN H. SHINN, *Specialist in Agricultural Education.*

The chief object of the work of the States Relations Service relating to agricultural instruction in schools is to make available to teachers and students of agriculture the agricultural knowledge constantly being accumulated by the Department of Agriculture, the agricultural colleges, and the experiment stations. Since the movement for the introduction of agriculture into secondary and elementary schools is now widespread and the up-to-date information on agricultural subjects in form for immediate use in the schools is comparatively meager the demand for this kind of service is steadily growing.

By cooperation with the bureaus of the department the services of its corps of specialists in the various branches of agriculture are made available in collecting the desired information. And through cooperation with the Federal Board for Vocational Education, as provided for in the vocational education act, the Bureau of Education, State departments of education, and agricultural colleges, the needs of the schools in different parts of the country are determined and complied with. In these ways the small force of specialists in agricultural instruction employed by the States Relations Service is enabled to render a useful service to the cause of agricultural education not performed by any other agency.

The work at present is being carried on along the following lines: (1) Cooperation with the Federal Board for Vocational Education in the preparation of publications for use in the secondary schools, particularly those receiving the benefits of the vocational education act; (2) cooperation with the States in preparing courses of study in agriculture for elementary schools; (3) cooperation with the teacher-training forces in the States by helpful publications, conferences, correspondence, and the loan of illustrative material; (4) cooperation with the teachers in service by furnishing information for use in their schools, by giving suggestions on the use of such material, by encouraging home project work, and by lending lantern slides on agricultural subjects.



In the recent cooperation with the Federal Board for Vocational Education two courses of study were prepared for southern schools, one in plant production and the other in animal production. The former was issued as Bulletin 53 of the Federal Board and the latter is now in press. Conferences were held at the Tuskegee Normal and Industrial Institute in Alabama and at Hampton Institute in Virginia with negro teachers from a number of States for the purpose of reviewing and explaining these courses and encouraging their use in the schools. A series of unit courses in various agricultural subjects was also begun in cooperation with the Federal Board for Vocational Education. One of these courses was completed and others are now in progress.

In cooperation with the State of Arkansas a course of study in agriculture is being prepared, which will be especially suited to the agriculture of the State and the requirements of the local elementary schools. A conference was held at the State Normal School, Conway, Ark., in August of 1919, to review and explain this course to the county superintendents of Arkansas.

In the matter of cooperating with the teacher-training forces, the two bulletins mentioned above, which were prepared in cooperation with the Federal Board for Vocational Education, will be very helpful. A bulletin prepared in this office on the Use of Illustrative Material in Teaching Agriculture has been in great demand. Forestry Lessons on Home Woodlands, prepared in cooperation with the Forest Service, is being issued as Department Bulletin 863. A number of leaflets on how teachers may use certain Farmers' Bulletins have been distributed. Classified lists of subject matter useful to teachers have been in great demand among agricultural teachers.

Cooperation with teachers in service is one of the chief functions of this division. The service is in touch with a large number of teachers who are furnished with such publications of the department as meet their special needs, together with suggestions on the use of such material and other information regarding the sources of agricultural knowledge, especially that which may be used in connection with the practical work of their students.

The demand for material along the line of visual instruction has been greater than the supply. During the year a new set of lantern slides on wheat was prepared. Some sets were revised, and duplicates were made of old sets in order to meet the increased demand. Several other sets are in the process of making. The lantern slides were more widely distributed than ever before, having been used in 42 of the States, in Canada, in France, and in the island of Guam. In Pennsylvania, West Virginia, Ohio, Virginia, Texas, New York, and North Dakota sets of lantern slides were placed in charge of the State departments of agricultural education to be sent out on circuits to schools teaching agriculture.

This division continues to review and abstract literature on agricultural education for Experiment Station Record. This work requires a large portion of the time of one member of the staff.

During the year field work was done by members of the staff at regional and State conferences of agricultural directors, supervisors, and teachers, and at meetings of associations at which agricultural instruction was discussed. State colleges giving attention to train-

ing of teachers of agriculture and schools giving instruction in agriculture were also visited. During these visits conferences were held to discuss problems confronting teachers in service.

Cooperation with the Association of Land-Grant Colleges was continued through its committee on instruction in agriculture, of which the director of the service is chairman. A report on the training of teachers of agriculture was made to the association at its annual meeting in November, 1919, and has been published in the proceedings of that meeting. The committee is now engaged on a study with reference to the improvement of college teaching of agriculture, having in view especially the requirements for the preparation of teachers for secondary schools and of extension workers, as well as of farmers.

There was also cooperation with the Bureau of Education in connection with the work of a committee assembled by the Commissioner of Education to study the problems of agricultural education with a view to fitting such education more closely and adequately to the actual conditions and environment of the farm and the needs of rural life. Two members of the staff of this service have served on the subcommittee, which has made a special study of the agricultural curriculum of the colleges and prepared a report which is being published by the Bureau of Education.

The work of this branch of this service was pursued under unusual difficulties during the year. Changes due to increased compensation offered for service elsewhere made the force engaged in this work comparatively a new one. In addition, the long, and finally fatal illness of Mr. Alvin Dille, who was in charge of the work, deprived the staff for a time of settled leadership.

Mr. Erwin H. Shinn, who was the chief assistant, was put in charge of the work, and the vacancy thus created was filled by the appointment of Mr. Frederick A. Merrill, who had been temporarily employed in connection with the school-garden work of the Bureau of Education and was formerly in charge of agricultural instruction in the State Normal School at Athens, Ga.

#### INVESTIGATIONS ON FARMERS' INSTITUTES.

J. M. STEDMAN, *Farmers' Institute Specialist.*

Farmers' institutes during the fiscal year ended June 30, 1920, were officially in charge of the State government in 16 States, while in the remaining 32 States they were in charge of the extension division of the agricultural colleges. A total of 35 States conducted farmers' institutes during the year. The combined reports from 30 of these States show a total of 4,542 institutes, which lasted 5,681 days, comprised 10,088 sessions, had an attendance of 1,268,094 persons, employed 1,045 lecturers, and cost \$203,890.

The States Relations Service continued to aid farmers' institute workers along the same lines as heretofore, and in so doing likewise aided county agents and other extension teachers throughout the country. Two new lectures, Green Manuring and Soy Beans, were published, each accompanied by 50 lantern slides. The 35 different illustrated lectures now available were used not only by farmers'

institute lecturers, but more especially by county agricultural agents, from whom the demand has increased to twice the supply of available material. They were also increasingly in demand from home-demonstration agents, club leaders, teachers of agriculture in high schools and vocational educational schools, extension teachers in agricultural colleges, grange lecturers, and other persons who desired aid in presenting their subjects before audiences of farmers. During the year illustrated lectures, each accompanied by a set of 50 lantern slides, were loaned to about 700 extension workers.

Conferences were held during the year with farmers' institute directors and lecturers in 13 of the States where farmers' institutes are most successful. The methods used in these States were discussed and a plan worked out for aiding the institutes in the less successful States.

The progress in agricultural extension in foreign countries was reviewed and the results will be made available to extension workers.

#### OFFICE OF EXPERIMENT STATIONS.

E. W. ALLEN, *Chief.*

The relation of the Office of Experiment Stations to the State stations receiving the Federal appropriation of the Hatch and Adams Acts for agricultural experiment and research was maintained along practically the same lines as heretofore, including administrative and advisory functions as well as the publication of the Experiment Station Record, the card index of American experiment station literature, and a report on the work and expenditures of the State and insular stations. The object of this supervision is not only that the provisions of the Federal laws may be carried out, but that the work may be encouraged by advice and assistance, and the welfare of the entire system promoted on the basis of broad study of conditions, progress, and needs. As heretofore, each of the stations has been visited during the year by a member of the office, detailed examination made of the work and relationships, and the opportunity embraced for discussion of questions of policy relating to this branch of activity.

#### RELATIONS WITH THE STATE AGRICULTURAL EXPERIMENT STATIONS.

The conditions arising from the war and its results which have been so universally felt throughout the country in all activities have been reflected in the situation surrounding the experiment stations. This has added materially to the problems of their administration and to the attention which the office has been called upon to give in the effort to maintain the standards, conserve the funds to the best advantage, and uphold the position of the stations as the research agency on which the success of other branches of the agricultural work ultimately depends.

With a view to setting forth from a national standpoint the actual conditions which prevail, data have been collected which have been presented to the Association of Land Grant Colleges and to the public generally. It was shown, for example, that for the fiscal years 1914 to 1919 there was practically no increase in the total Federal



and State appropriations for the State experiment stations. The Federal appropriation remained stationary, and the allotments made by the States increased in the six-year period by less than \$160,000, or quite within the fluctuations of the total State appropriation from year to year. During the fiscal year several of the State legislatures made more ample provision for the stations, but the aggregate was relatively small, and there was no general measure of relief by such action because the increases were limited to a comparatively few States. Some of the stations in the greatest need of assistance and whose work is of national importance did not receive any increase in financial support.

The last provision for Federal aid of the stations was carried in the Adams Act of 1906, 14 years ago. The States have met this twice over in the aggregate, as they have the previous provision under the Hatch Act of 1887. These two Federal acts provide a total of \$1,440,000 a year, while the States in the fiscal year 1919 contributed a total of \$2,734,000. The total for the fiscal year 1920 would probably amount to \$3,000,000.

Up to 1914 the States had been doubling their total appropriation about every five years. This policy ceased with the outbreak of the war, and the cessation is likewise coincident with the passage of the Smith-Lever Act for agricultural extension. The latter fact presents a remarkable anomaly—that of providing a vast and growing system for the popular dissemination of information while halting the growth of the agency on which it must depend for its very stock in trade. The effect has been that the research work as represented by the stations has fallen steadily behind the growth of other activities of the college, and thus has lost in force and effectiveness.

The stations as a group, therefore, came to the period of inflated prices with only a prewar revenue to work upon, and with very unusual difficulties to face, not the least of which was the keen competition for workers. While relief has been provided in a few of the States, the conviction is forced beyond doubt that the great body of the stations have reached the limit of their ability to maintain a satisfactory output and keep step with the advance in the demands of teaching and extension. The price which is being paid as a result of their present condition is a heavy one, as has been developed by the survey which the office has maintained of the entire country. It is expressed in a slowing up of research, a diminished force of attack, attention to questions of smaller range or simpler character, and a falling off in publications.

The station forces have suffered severely, from the administrative head downward. Since 1914 the directors of half the stations have changed, several of them more than once. In eight instances the directorship, which was formerly separate, has been combined with other offices, that of president of the college, dean, or director of extension. The effect of these combinations, frequently made in the interest of economy, has been to quite materially decrease the administrative supervision of the station affairs, and in some cases to provide less expert supervision of its work. The total number of separations from the stations in the last six years represents an approximate turnover in the personnel of about 80 per cent. Of those who left, 370 ranked as heads of departments or project leaders, the

remainder, aside from directors, being of the grade of assistants, superintendents, etc. By actual count there has been a decline of 250 in the number of persons on the station forces, from an average of about 1,700.

Such widespread changes tend inevitably to the disorganization of the work and seriously interfere with its progress. This handicap involves not only the interruptions entailed but the difficulty of securing properly trained men to fill the places. This condition is not only serious in itself but there is danger that it may become more so in the future unless the inducements for young men and women to adequately prepare themselves for research work are made more attractive. Every effort is being made by the stations to meet, in part at least, the competition in salaries that is now attracting so many away from investigational work.

Another feature is found to be the extent to which station workers are being called upon to assist in the teaching and other activities of the colleges. This increasing tendency to combine the research positions with other duties, often resulting from necessity, is a reversion to a practice which early in the history of the stations was found to be disadvantageous to thoroughgoing investigation.

The experiment stations are passing through a critical stage in their existence which it will require the strongest organized efforts and broad public appreciation for them to withstand. Research from its very nature comes but little in the public eye until it is incorporated in the teachings of the lecture room or disseminated among the farmers, when its source is apt to receive little thought. A fuller understanding of the part played by the stations in the progress of agriculture would help largely in calling attention to their needs. There is need for greater publicity in their behalf.

The stations will need more funds to play the part and occupy the place they should. The prospects for increased State appropriations for the coming year are encouraging in many instances, and there is ground for hope that the tide is already turning. With proper guidance this should eventually mean a return of a more settled and stable condition.

#### EXPERIMENT STATION RECORD.

The program for the year included the publication of volumes 41 and 42 of Experiment Station Record, each consisting of nine numbers and the usual author and subject indexes. These volumes contain 7,101 abstracts of the world's scientific literature pertaining to agriculture, together with the usual monthly editorials discussing important phases of the developments in agricultural investigation and brief notes on the progress of institutions for agricultural education and research in this country and abroad. The total number of articles abstracted was slightly larger than that for the previous year.

There was no change of policy as to the scope and treatment of material. Special efforts, however, were made to advance the time of issue so that the numbers would be in the readers' hands early in the month of publication. A definite schedule to this end was worked out with the Government Printing Office and the preparation of the



issues was advanced to a current basis, although inability to secure paper of the quality hitherto deemed essential for a permanent reference work such as the Record was causing unexpected delays in printing at the close of the year.

Beginning with volume 42, two mechanical changes were adopted. The first of these was the trimming of the pages of the individual issues, and the second the substitution of a new and more conspicuous type for the titles of the various abstracts and notes. Both of these changes were intended to promote the convenience of the users of the Record, and have brought many expressions of approval.

Steps were also taken within the year to distribute the surplus stock of back numbers, for which adequate storage space was no longer available. The opportunity thus afforded institutions and individuals to complete their files was quite freely used, the many requests indicating in a concrete way the value attached to the publication.

No general index of the Record has been prepared since 1911, the last issue including volumes 13 to 25. It has been the intention to issue a similar index covering volumes 26 to 40 as soon as possible after the completion of the latter volume, but the shortage of the printing fund has thus far rendered its preparation impracticable. The need of such a combined index and the widespread demand for it are alike unquestioned.

#### INSULAR STATIONS.

The Division of Insular Stations continues to represent this department in the administration of the work and expenditures of the Federal experiment stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands.

During the year the stations began a readjustment from the active campaign for food production and conservation to the less spectacular but equally essential investigation of fundamentals of agriculture. In many instances the work during the war indicated lines of experimentation that needed development in order to present a program for diversified agriculture for the territory served by the stations. Conditions since the war have necessitated a study of all the projects at the different stations and the elimination of those that are not connected with some urgent problem. Even with a careful revision of the lines of work the stations find themselves seriously handicapped by a lack of funds. Everything connected with the cost of operating the stations has increased, but the revenues have not been augmented in like proportion. The appropriations for the stations for 1920 were: Alaska, \$75,000; Hawaii, \$50,000; Porto Rico, \$50,000; Guam, \$20,000; and Virgin Islands, \$15,000. These sums constituted their entire resources, the funds arising from the sale of products being no longer available for the maintenance of the stations. The stations covered into the Treasury of the United States as miscellaneous receipts \$10,502.96 during the fiscal year ending June 30, 1920.

The stations almost without exception are in need of additional buildings to properly house the staff and to provide laboratory and other facilities. Most of them are so remotely situated that resi-



dences must be provided for the permanent members of the staff and in some cases for laborers as well. In the earlier days of the stations buildings were erected from the sales' fund or from the regular appropriation whenever that was possible. In some instances Territorial assistance was secured for the construction of buildings, but this can no longer be counted upon. As a result of the limited funds the number and character of the buildings were restricted to the minimum requirements. In Alaska many of the buildings were constructed of green or only partly seasoned logs. These are now in such a condition of decay that modern cottages and barns are needed for housing the men and their families and for properly protecting the stock, forage, grain, and implements. At the Hawaii and Porto Rico stations extensive repairs are urgently needed. The Guam station requires additional cottages and adequate housing for the stock and grain. The Virgin Islands station has only the old buildings of a former sugar estate and extensive remodeling is needed to adapt them to the station's use. Two new cottages are required for members of the staff, as the present equipment is not sufficient in number, convenience, or sanitary equipment. In order to properly man the stations and keep up the morale of the personnel and thus avoid frequent changes some concession must be made to counterbalance the remoteness and isolation of the stations.

It is believed that more adequate provision should be made for extension work in connection with the insular stations. Work of this character is carried on in a limited way in Hawaii, Porto Rico, and Guam, but it is thought that more attention should be given to its development, not only by the stations now engaged in it, but also by those which are not undertaking such work on account of a lack of funds. All the stations have information of great practical value to impart, but are prevented from doing so by a lack of funds to carry the work to the farmers at their homes. None of the regions served by the insular stations enjoys the benefit of the legislation which provides for the extension work in the States, and it is hoped that this omission will be compensated by increased appropriations to the stations which are the only competent bodies to carry on this work.

No changes were made in the executive heads of the stations, though there were many resignations of the investigational staff.

The stations continue to enjoy the hearty cooperation of various bureaus and divisions of the department and most hearty acknowledgement is made for the aid thus received.

The administrative and financial review of the affairs of the stations in connection with the State Relations Service continued as formerly under the supervision of Walter H. Evans and the accounting office of the service.

#### ALASKA STATIONS.

The Alaska stations reported a very successful year. The construction work at the Kodiak and Matanuska stations was nearly completed and purchases of live stock for the Matanuska station were made. After considerable investigation it was decided to undertake the introduction of milking Shorthorn cattle, and five head were purchased for the Matanuska station and two for the Fairbanks

station. In addition there were secured for the Fairbanks station some Hampshire hogs and Toggenburg goats. After adequate provisions are made for their care, some of the Galloway cattle now at Kodiak will be transferred to Matanuska and Fairbanks. Two yak were secured through the Canadian Government from the herd at Banff, and these were taken to Fairbanks where experiments in crossing them with Galloways will be undertaken. It is believed that a hardy race of cattle can be developed in this way, but in order to make the experiment a success additional yak will be needed.

At Kodiak the herd at the end of 1919 consisted of 46 head of all ages—23 purebred Galloways, 9 purebred Holstein, 6 crossbred Holstein-Galloways, and 8 Galloways in the tuberculous herd which were being used for breeding experiments according to the Bang method. The station has been quite successful in rearing calves from reacting dams and there has been no case of reacting to the tuberculin test in the young stock. The sheep at the Kodiak station now number 23, with a purebred Lincoln ram at the head.

The crop work at the several stations continues about as formerly. Several hybrid barleys and oats have been given further test at the Rampart station, and their early ripening and quality commend them for extended trial in other regions. Some very promising spring wheats have been produced which are being grown in increase plots for distribution to farmers throughout the interior of Alaska. At the Fairbanks station the work is carried on on a field scale for most part, and many of the hybrids developed at Rampart are given their first extended trial at Fairbanks. Advantage is taken of its location to make use of the Fairbanks station for demonstrating the agricultural possibilities of that portion of Alaska. From the station a distribution of seed grain was made to the farmers in 1918 in an effort to induce them to begin grain production on an independent basis. So successful were these efforts that in the summer of 1919 there were thrashed for 22 farmers in the Tanana Valley 1,128 bushels of spring wheat, 2,811 bushels of oats, and 121 bushels of barley. During the same season the station produced 303 bushels of spring wheat, 774 bushels of oats, and 125 bushels of barley. As a result of this production and the demonstrated quality of the flour a cooperative 25-barrel flouring mill has been purchased for erection at Fairbanks.

In the Matanuska region fully 1,000 bushels of grain were produced in 1919. The work of clearing and building at this station, which was established in 1917, is progressing favorably, and experiments have been begun with crops that appear suited to the region. Root crops do well in this locality, which is contiguous to the railroad being built from the coast to Fairbanks, potatoes and turnips giving very satisfactory yields. Experiments were begun in 1918 with sugar beets. Samples of beets grown in 1919 averaged about 1 pound each, and of 20 beets that were analyzed the sucrose varied from 17 to 21.4 per cent, with a coefficient of purity ranging from 78.9 to 83.3 per cent.

An horticultural nursery has been established at the Matanuska station, where it is planned to not only carry on experiments with all sorts of hardy tree and bush fruits, but to grow them in sufficient quantity to supply homesteaders in the region contiguous to the station.

As an emergency program during the war, some efforts were made to carry on extension work in the Tanana and Matanuska Valleys, and considerable interest was aroused in agricultural production. With the resumption of the usual investigations it was no longer possible to continue this effort. It is now quite apparent that extension work is needed throughout the whole of the interior valleys. The settlers were in the main attracted to Alaska on account of its mineral and fishing industries and often had but little agricultural experience. Many of them are in need of experienced advice with their problems and unless their efforts are properly directed they may fail. The agronomist in charge of the station strongly urges provision for an extension agent who shall devote all his time to studying the farmer's problems and advising him how to succeed under conditions with which he may not be familiar. The Alaska advisory committee, appointed by the Secretary of the Interior, recommend the appointment of such an advisor as an important part in the development of the Territory.

#### HAWAII STATION.

The station has continued to direct its investigations toward the proper diversification of the agriculture of the islands and especially to the production, preservation, and utilization of food products. Very satisfactory results were obtained in the manufacture of starches from a considerable number of locally produced crops and from experiments in the drying of fruits and vegetables. Some of these products are now under investigation in the Office of Home Economics and a report upon them is expected soon. The possibility of the commercial production of some of these products seems assured. The growing of cassava on an extended scale in Hawaii has been resumed, owing largely to the station's efforts in securing better varieties and the demonstration of the use of the roots for feeding purposes, culinary use, and for making starch. The edible canna is being widely grown and its tuber like roots are used as a substitute for white potatoes and for starch, the latter having proved especially valuable as food for invalids. Among the horticultural projects especial attention was given to improved mangoes, avocados, papayas, and to nuts, particularly the Macadamia nut, the dissemination of which has been quite rapid since its introduction. Efforts are being concentrated on the propagation and dissemination of the Pirie mango and the Solo papaya, two superior varieties for Hawaii. The chemical division has begun a study of the requirements of the banana for plant-food elements and has a large number of plats devoted to this investigation. Rotation experiments, combined with fertility investigations, are in progress on many types of soils and with many crops. It is hoped that from these experiments the station will be able to recommend profitable crop rotations for the different islands.

The work with corn, pigeon peas, sweet potatoes, and various other forage and feeding stuffs continues to receive much attention, and through the breeding up of locally established varieties the acre yield of some of the improved strains is more than double that of the parent varieties. A new variety of cowpea, that is believed to be an accidental hybrid, is being rapidly propagated for distribution.



When cut two months after seeding it produced more than 4 tons of green feed per acre, and from the second growth a good crop of seed was produced.

The pathologist, just before he resigned to join the staff of the Hawaii sugar planters' experiment station, had brought his root-rot studies to a point where the common origin of rots of rice, taro, bananas, sugar cane, and pineapples seemed to be indicated. The possible bearing of his discovery on the Lahaina disease of sugar cane led to his transfer to the sugar experiment station, where he can devote more of his attention to this phase of the problem. Cooperative work on the control of taro rot and the banana freckle-spot disease seem to offer some very promising results.

The demonstration work at Haiku, Maui, continues to give excellent data for use in the extension work of the station. Fertilizer experiments begun several years ago are beginning to show the needs of Hawaiian soils for phosphatic fertilizers. The possibility of growing various constituents to enter into concentrated feeding stuffs has been successfully demonstrated, and a number of mixed feeds of local origin are now on the market. The Haiku station as a source from which to obtain improved strains and varieties of various crops is recognized widely and there is a constant demand for all surplus seeds and plants.

The extension work is progressing as well as could be expected with the funds available for this purpose. The work on Maui and Hawaii, where extension agents are permanently located, is beginning to show satisfactory results. Some attempts have been made to organize club work among the boys and girls, and home demonstration work among the families of the islands. In the latter the wives of members of the staff took an active part, and the results from such limited opportunities were so encouraging that the station desires to continue and expand its club and home demonstration work. It is thought that through these agencies much good could be accomplished and at the same time attention called to the other work of the station. The population of Hawaii is composed of peoples of many nationalities, and most of them can be reached and influenced only by direct contact, and on this account a further development of the extension work is considered desirable.

For several years the station has cooperated with the War Department in the production of forage, and now the commanding general of the Department of Hawaii has requested further cooperation in a campaign for the production of more adequate food supplies. The importance of this work is recognized, but the station can not enter into the work very energetically with its present income and staff.

#### PORTO RICO STATION.

The lines of work of the station during the year have been less along the production of emergency food and more generally devoted to fundamental research. The production of some food crops that was stimulated during the war continues to be satisfactory, and of beans the local demand can now be readily supplied and there is a considerable surplus for export.

Chemical studies are made with rice in water and soil cultures to determine the fertilizer requirements of this crop and also the in-

fluence of phosphatic fertilizers on chlorosis. Experiments are in progress in which the effect of lime, leguminous crops, cane residues, and various chemical fertilizers on the nitrogen balance of the soil are being investigated.

On account of the presence in Porto Rico of the mosaic, or mottling, disease of sugar cane, work with immune or resistant varieties of cane is being emphasized. The station is now growing two varieties that appear to be wholly immune and several others that have such a high degree of resistance that they give large yields in spite of the presence of the disease. These varieties are being propagated as rapidly as possible for distribution to planters. In connection with the production of food crops the work with beans and rice is continuing to receive much attention. A large number of varieties of beans have been tested, and those already acclimated to tropical conditions appear most promising for extended trial. A black bean from Venezuela is giving the best yields, but local prejudice against its color prevents its more extended planting. Some mutants ranging in color from white to purple have been found, and these are being carefully studied to find colors that are acceptable and at the same time prolific in yield. The work with rice has been continued, but on a reduced scale, as it was impossible to secure the cooperation of managers of large plantations owing to their interest in sugar-cane growing. Tests of 145 samples of native upland rices were made in the station trial plats, from which it is hoped to develop valuable strains for hillside planting. The station has been active in introducing a number of new crops, and much interest has been aroused in cowpeas, soy beans, mung beans, and improved varieties of chickpeas. Additional cover crops have been tested and *Crotalaria juncea*, a recent introduction to Porto Rico, gave a yield of 12.6 tons in 10 weeks from planting. Napier, or elephant grass, introduced by the station a few years ago, is proving adapted to almost every type of soil and its distribution is proceeding rapidly.

The investigation of vanilla as a possible new industry is being continued, and the crop of the last season was sold at \$3 per pound. Experiments are in progress on methods of curing and preparing for market that appear to indicate a higher grade of product. The yields obtained suggest conditions under which maximum production may be expected. One large commercial planting of vanilla has been made as a result of the station's investigations and others are contemplated.

Work with vegetables is being given especial attention at the station and also on other types of soil in several localities in the island. Success has been met with in the production of a large range of standard vegetables, and improved strains are being more generally planted throughout the island. The work with wilt-resistant tomatoes seems especially promising, and it is hoped that resistant strains of good quality will be available for distribution in the near future.

A study is being made of the causes contributory to citrus scab, especially the effect of certain fertilizers, cover crops, cultivation, location of groves, etc. A mosquito survey of Mayaguez and vicinity was made in cooperation with the sanitary authorities of the city.

The extension work has been actively pursued, and in cooperation with the special teachers of agriculture data are being obtained on yields and cost of production of all crops grown on the island. Through the efforts of the extension division considerable progress has been made in bringing about closer cooperation in the two citrus fruit organizations and a number of independent growers. It is expected that this will result in cooperative purchase of supplies and in the packing and marketing of the entire crop. Meetings are held throughout the island at which the farmers' problems are discussed, and a considerable amount of information is distributed through mimeographed circulars issued monthly by the station. The mailing lists for these circulars are growing rapidly.

In 1917 the station erected the first dipping tank for the eradication of cattle ticks in the island. By regularly dipping its cattle the station grounds have been freed from ticks, to the great improvement of the condition of the stock. The use of the tank has been made available to planters in the neighborhood, and during the first six months of the fiscal year 1,495 head of cattle were dipped in the station tank. The desirability of tick eradication has been generally recognized, and 35 tanks have been constructed in various parts of the island. The public has been pretty well educated to the desirability of tick eradication, and it is believed that the station should coordinate and direct the various agencies so as to bring about a tick-free condition as soon as possible. When this is accomplished the introduction of purebred cattle can be recommended with the assurance that the losses now experienced can be avoided. Nothing else would so contribute to the welfare of the island as a well-developed dairy industry, but this can not be brought about so long as ticks are a menace.

#### GUAM STATION.

One of the most important events of the year at the Guam station was the addition of some purebred stock to its breeding herds and flocks. On February 5, 1920, after a tempestuous voyage there were landed safely in Guam two Ayrshire bulls, two Berkshire boars, and a number of Rhode Island Red cockerels and pullets. This is the largest addition to the live stock of the station since the first shipment in 1911, and its arrival will enable the breeding work to be continued without the danger of too much inbreeding.

In addition to the breeding projects with all the different kinds of stock, feeding experiments have been begun to find, if possible, local sources of feed that may supplant those now imported from the States. For many rations copra meal has been found a satisfactory substitute for about one-half the grain usually fed. The superiority of Para and Paspalum grasses both for pasture and as soiling crops over the native grasses has been demonstrated, and the planting of these introduced grasses is being extended rapidly. The value of cowpeas for food and forage is becoming recognized and the people of Guam are planting increased areas with seed furnished by the station. Especial attention is being given to chicken breeding and feeding, as this work seems to appeal particularly to the people of the island. The experiment in producing a new breed of chickens by crossing the Rhode Island Red with an especially promising



strain of native fowl is being continued with promise of success. The goat-breeding experiments, previously reported upon, have not been extended because of the lack of purebred sires. Increase breeding with half-blood Toggenburgs is being continued.

The work in agronomy was largely with root and forage crops and soil studies, especial emphasis being given to local crops and imported ones for which there is a demand. The size of the plats in the agronomy work was increased so as to more nearly represent field conditions. Cost accounting has been begun to determine the cost of producing some of the more important crops. The cost of preparing the land and planting *Paspalum*, a valuable forage grass introduced by the station, was \$42.69; milo and sorghum, \$9.44; velvet beans, \$22.95; pigeon peas, \$10.91; cowpeas, \$6.79; and sweet potatoes, \$11.74 per acre. The higher cost for *Paspalum* is due to the fact that it is propagated by planting root divisions and stem cuttings.

As the work in Guam progresses it is found that there are many peculiar soil problems. Analyses have shown the presence of some very unusual soils, and pot experiments are in progress to determine their adaptability to various crops. Another series of soil experiments is being carried on to ascertain, if possible, the cause of the frequent infertility of newly-plowed land as compared with the same soils after being cropped for a few years.

The horticultural work was largely the growing of vegetables and the restoration of the orchards and permanent plantings that were badly damaged by the typhoon of July 6, 1918. By pruning, staking, budding, grafting, etc., all the more valuable varieties were saved, and in addition new plantings of other tropical fruits in better locations were made. Considerable success is reported in the growing of vegetables, and the people of the island are giving considerable attention to their cultivation. Supplies of fresh vegetables are now to be found in the local markets that can be easily traced to the work of the station in introducing and developing them.

The extension department of the station had a very successful year. Three lines of work are in progress—adult demonstrations, boys' and girls' clubs, and school gardens. The adult demonstrations are carried on with the best farmers in the different localities, and they are expected to give to neighbors for planting an amount of seed equal to that supplied them by the station. This plan is working very successfully and is considered responsible for the large areas now planted to cowpeas. At the close of the fiscal year 145 farmers in six districts were conducting demonstrations with this crop. School gardens are maintained throughout the island, and in the absence of agriculturally trained teachers the extension agent is called upon to prepare all planting and cultivating schedules. The value of produce sold from school gardens to March 15, 1920, was \$184.40, with many of the more important crops yet to be harvested. The club work, which was first organized in March, 1919, has proved very popular, and corn, bean, taro, copra, pig, and poultry-raising clubs have been formed. A total enrollment of 545, out of a school enumeration of about 2,200, was reported. Of this number, 439, or 80 per cent, completed their year's work and submitted reports and stories of their achievements. The value of the products raised by

these club members was \$3,513.63. At the last agricultural and industrial fair held at Agana February, 1920, boys' and girls' club members contributed 375 out of 557 exhibits, and they won a large percentage of the prizes in the classes in which they exhibited. The extension work is developing rapidly, and it is believed through this agency much can be accomplished of permanent value to the agricultural development of the island. To more efficiently carry on this work, better facilities for travel are needed.

#### VIRGIN ISLANDS STATION.

The work of the Virgin Islands station has been continued very largely along the lines developed before the station was acquired by this department. The principal investigations have been in agronomy—sugar cane, corn, and Sea-Island cotton receiving the most attention. During the year an entomologist was added to the staff and he has begun a survey of the islands to determine the most troublesome pests, and has inaugurated some experiments for their control. A collection of the scale insects of the Virgin Islands has been begun and nearly 50 species have been collected and identified. Experiments have shown that most of these insects can be controlled by the use of kerosene emulsion to which fusel oil is added.

The work of breeding and testing new varieties of sugar cane is being continued with very good success. The variety S. C. 12/4 bred at the station continues to give large yields of cane having a high sugar content, and its cultivation is being extended on a number of plantations. Several other new seedling varieties are very promising and their field trial is being begun. More than 100,000 cuttings were distributed to various estates for trial during the year. About 3,000 new seedlings were grown during the fiscal year 1920, but many were lost due to a severe drought that lasted from February to June.

The station's cotton-breeding experiments are being continued. About 180 acres of Sea-Island cotton was planted in St. Croix, the seed being secured from the station. An average yield of 600 pounds of seed cotton per acre was secured. The crop of 1918-19 averaged 1,000 pounds of seed cotton per acre and ginned about 27 per cent lint, which was sold in Liverpool at from \$1.80 to \$2 per pound. In the plat work at the station one strain yielded at the rate of 4,000 pounds of seed cotton per acre, the lint being  $1\frac{3}{4}$  inches long, strong, and of good color and luster. Twenty-six samples of hand-ginned cotton were submitted to the Bureau of Markets of the Department for judging according to the official cotton standards for Sea-Island cotton. The lint ranged from  $1\frac{1}{2}$  to  $1\frac{3}{4}$  inches in the different lots. Some of the samples were considered worth a premium over the grades of Sea-Island cotton. One variety of cotton growing at the station has been found comparatively resistant to the blister mite, one of the most serious cotton pests of the island. The corn investigations of the station consist of breeding work and studies of methods of planting. An attempt is being made to secure a fixed variety for general cultivation and by hybridizing to produce a table corn adapted to the Tropics. A considerable number of crosses have been made from which to select the types best suited to the conditions of the experiment.

The growing of vegetables and fruits is badly neglected in the Virgin Islands, and the station has begun experiments on the adaptability of well-known varieties of common tropical and temperate climate fruits and vegetables. Tomatoes, string beans, carrots, kohlrabi, beets, etc., were all grown very successfully during the past year. Cabbage, melons, cucumbers, and others grew well, but were badly injured by insect attacks. Experiments are in progress for the control of these pests. An effort is being made to introduce the papaya into general use as a fruit and vegetable, and a large amount of seed was distributed throughout the island. Plantings of mangoes, avocados, and citrus trees were made at the station, and some of the lime trees in the small orchard planted in 1915 have been successfully top-worked to grapefruit. On account of the limited supplies of fruits and vegetables in variety, especial efforts will be made not only in St. Croix but in the other islands to stimulate their production.

#### OFFICE OF EXTENSION WORK IN THE SOUTH.

J. A. EVANS, *Chief.*

The Office of Extension Work in the South has charge of the cooperative extension work of the Department of Agriculture in the 15 Southern States. Except the decrease in administrative organization, noted below, its functions, administrative organization, and relationships with the subject-matter bureaus of the department and with the State extension services remained unchanged.

#### ADMINISTRATIVE FORCE.

January 15, 1920, Dr. Bradford Knapp, who had been chief of the Office of Extension Work South from the time of its organization in 1915, retired from the service of the department to become dean of the College of Agriculture of the University of Arkansas and director of the Arkansas Experiment Station. Dr. Knapp had been associated with his father, Dr. Seaman A. Knapp, in the early development of the farmers' cooperative demonstration work in the Southern States, and succeeded him in the administration of that work while it was connected with the Bureau of Plant Industry. The broad knowledge of southern agriculture possessed by Dr. Bradford Knapp, and his leadership in the movement for the improvement of southern agriculture through the cooperation of farmers, business men, and extension agents, made his services very valuable and his withdrawal from our service was greatly regretted. His successor is Mr. J. A. Evans, formerly assistant chief of the southern extension office, who has been connected with the demonstration work since February 12, 1904.

Within the Department of Agriculture the Office of Extension Work in the South was represented at the close of the year by one chief, one assistant chief, three field agents in the administration of the county agent and cooperative extension work in the States; four men and four women in the administration of the home-demonstration work and the boys' and girls' club work; and the necessary office assistants and clerical force. There was a decrease of two in



the administrative staff for county agents and cooperative extension work in the States, and one in the administration staff for women and girls' work during the fiscal year.

In addition there were two negro field agents, with offices in the field, but under the direct supervision of the Washington office.

At the close of the year ended June 30, 1920, there were in the Southern States 15 directors of extension, 15 State agents or assistant directors, 61 assistant State and district agents, 834 county agents, 35 assistant county agents, 158 negro agents, 77 boys' club agents, 15 State home-demonstration agents, 77 assistant State home-demonstration agents and district agents, 564 county home-demonstration agents, 74 negro women agents; total, 1,925. This is 335 fewer men and 438 fewer women than were employed in all capacities in the southern extension work at the close of the fiscal year 1919.

There were also during the year 10 representatives of subject-matter bureaus of the department cooperating with the Office of Extension Work in the South in taking technical information from the department to the States.

#### FINANCES.

The total amount available for extension work in the 15 Southern States in 1919-20 was \$5,352,300. Of this amount the Federal Government contributed \$2,682,119, including \$495,000 from direct appropriations to the States Relations Service for farm demonstration work, \$168,600 from appropriations to other bureaus of the Department of Agriculture, \$1,343,880 under the provisions of the Smith-Lever Act, and \$674,600 from funds appropriated to supplement the regular Smith-Lever funds. The States contributed \$1,868,519 to offset the latter two amounts. In addition, there was available from State and college funds, \$52,400; from county funds, \$718,900; and from other miscellaneous sources, \$30,425. These funds were used as follows: For administration, \$339,600; county-agent work, \$2,541,800; home-demonstration work, \$1,422,600; boys' agricultural club work, \$159,500; specialists, \$796,800; publications, \$92,100.

#### COUNTY AGENTS.

##### ORGANIZATION.

During the year the number of definite organizations within the counties cooperating with the county agent and the State extension service has been greatly increased. In a number of the States these organizations have taken the form of farm bureaus with paid membership, and in other States the county organization is known as the county farm council or county council of agriculture. In the majority of the Southern States these organizations still consist of voluntary community organizations of farmers and their families on a nonfee basis. In all cases these county and community organizations cooperate with the county agents in outlining community and county plans of work and participate actively in carrying out the programs thus outlined. The main features of work usually undertaken through these organizations comprise field demonstrations conducted by the farmer, and marketing activities through the local and county

organizations. Meetings are held from time to time, and miscellaneous information is given for the purpose of assisting individuals in solving their farm problems.

#### PLAN OF WORK.

In the South the county agricultural agent and the county home-demonstration agent are the recognized leaders in all agricultural extension activities in the county. Through them the efforts of all members of the extension service—State and district agents, specialists from the State agricultural college and the United States Department of Agriculture, and State and district club agents—reach the farmer and his family. The county agricultural agent is responsible in his county for all lines of work with men and the boys' club work, and the home-demonstration agent is responsible for all lines of work with women and the girls' club work. Usually a definite written plan of work for the year is agreed upon for the county by the agents in cooperation with district agents and specialists and the advisory committee of the supporting county organization. Such plans are submitted to the cooperative extension authorities of the State for approval. The plan includes a program of demonstrations, both individual and community, with crops and live stock, special campaigns, field meetings, organization work, marketing, organization of clubs, etc.

#### RESULTS.

The extension work in the South, in common with every other activity, has had to undergo more or less readjustment since the war. The decrease in funds made it necessary to greatly decrease the force of agents, both men and women, within the States, and in all cases it has been found a little difficult to abandon the promiscuous activities so necessary during the war period and concentrate on definite programs of extension work. Notwithstanding the temptation of high prices for cotton and other sectional money crops, the general effect of a continuous and consistent program for better balanced farming has been maintained, as evidenced in improved and increased production of food and feed crops as well as live stock, and in development of cooperative marketing and purchasing.

In the 11 cotton States the increased acreage in various crops over those shown in the census of 1909 was as follows: Corn, 20 per cent; wheat, 203 per cent; oats, 125 per cent; hay, 155 per cent; Irish potatoes, 67 per cent; sweet potatoes, 72 per cent; rice, 31 per cent; peanuts, 44 per cent. Grain sorghums have increased from 1915 to 1919, 30 per cent in Texas and Oklahoma alone, and velvet beans increased from a small acreage in 1910 to 3,434,000 acres in 1919. The acreage of cotton in 1919 was exceeded seven times during the last 10 years.

The live-stock industry in the South has shown steady and gratifying gains. The number of dairy cows and "other cattle" was increased over previous years, as was also the number of hogs. The boys' pig clubs, which have continued to grow in popularity and numbers, have been an outstanding influence in introducing pure-bred hogs in all sections of the South. The number of hogs shipped

cooperatively was greatly increased. Practically every county in the South having a county agent shipped a large portion of their marketable hogs in this way during the year. The total number of hogs in the Southern States has increased by 31 per cent since 1910. Of the 20 States ranking highest in point of hog production, 10 are in the southern territory.

#### DEMONSTRATIONS.

Actual field demonstrations conducted by the farmer on his own land under the guidance of the county agent and specialists remain the basis of county-agent work in the South. Where the community organizations cooperate fully in extension work the demonstrations are usually on a community basis, following the definite plan of work adopted in cooperation with the local organization, and is for the purpose of illustrating the agricultural practices best adapted to the section.

The total number of acres in crop demonstrations in 1919 was 2,664,723. The total number of farmers demonstrating was 246,982. These demonstrations have dealt with all of the more important phases of crop and live-stock production in the South as well as with cooperative marketing and purchasing. The largest acreage in demonstrations with one crop was in corn. More than 57,000 demonstrators cultivated a total of 645,716 acres under special instruction, with an average yield of 37 bushels an acre, or more than double the average yield of the whole territory. The county agents were especially active during the year in the work of introducing improved live stock, and securing the adoption of better methods of feeding and care and protection against diseases and pests. County agents have everywhere urged the necessity of tick eradication, and assisted in stocking the counties with improved cattle after the territory has been released from quarantine.

The great growth of cooperative marketing and purchasing has been one of the outstanding results of extension work in the South. County agents, assisted by marketing specialists, through marketing demonstrations and by instruction and advice, have aided local and county associations of farmers in the cooperative selling of all kinds of farm produce and live stock, and in the cooperative purchasing of a great variety of farm necessities. Education in business systems of marketing and purchasing of staple farm supplies has been one of the vital needs of this section, and in no phase of extension work has the assistance of county agents been more highly appreciated or secured more outstanding results. In most of the States the Bureau of Markets of the United States Department of Agriculture has specialists in marketing either in direct or very close cooperation with the extension divisions of the colleges. In a number of the States there is also close cooperation between the State departments of agriculture and the extension divisions of the agricultural colleges in this activity. The grand total value of all products cooperatively marketed or purchased through the assistance and advice of county agents during the year was \$34,534,886, representing a saving of \$4,547,418, or over 13 per cent on the total volume of business.



As farmers have gained knowledge of methods and acquired confidence in their ability to do business on a cooperative basis they are beginning to undertake definite business organizations on a county-wide or even State-wide scale for the marketing of their main cash crops, such as cotton, tobacco, peanuts, etc.

Owing to the cooperative work in cotton grading, classing, and stapling, and information given as to the market value of the various grades and staples by the extension division of Texas in cooperation with the Bureau of Markets, it is estimated that between \$1,000,000 and \$2,000,000 were saved to the cotton farmers of that State alone during the year in increased returns for the cotton graded, classed, and sold in this way. Considerable work of this kind was also done in a tentative way in the other cotton States. The results have been such as encourage most of the States to plan for greatly enlarged programs of work along this line for the ensuing year.

#### HOME-DEMONSTRATION WORK AND GIRLS' CLUB WORK.

Home-demonstration work for women and girls was organized to render to the rural home a service similar to that which is done for the farm through the county agricultural agent. It is organized as a definite part of the State extension service, and represents the cooperative effort of the State agricultural college and the United States Department of Agriculture, and counties and communities. In the majority of the States in the South the home-demonstration division of the extension service carries the entire extension work for women and girls. The work is organized on much the same basis in all the States. There is a woman in charge of the work in every State. In Virginia, Tennessee, North Carolina, South Carolina, Georgia, Florida, Mississippi, Louisiana, Texas, Oklahoma, and Arkansas she is practically an assistant director, responsible to the director of extension and in charge of the home-demonstration work for women and girls.

Organization of rural people, as a result of extension work both in agriculture and in home economics, has been remarkably rapid, the clubs of women and girls often, though not always, representing a community organization. More and more, however, is real community organization developing out of these women's and girls' clubs; men and women, boys and girls being thus brought together for purposes of community betterment or social intercourse and recreation.

In most counties the home-demonstration agent has a woman's advisory committee with which she confers as to types of work to be carried on, as well as regarding any important problems that may arise. Rural women are developing surprising qualities of leadership, and aside from membership in their local clubs, whose meetings they conduct in strictly parliamentary style, they are being appointed as members of the community as well as county farm and home councils. As such they share with the men the responsibility of shaping policies and directing affairs affecting the general improvement of their communities.

As organization of rural women progresses, community enterprises are being fostered more and more. Egg circles are formed

and the members learn to grade and pack their eggs carefully in standardized cartons. By cooperative shipping and marketing, better markets and better prices are secured. The women themselves, moreover, are rapidly being trained in up-to-date business methods.

Curb markets have been established in many towns, providing opportunity for the rural women to bring in their butter, eggs, poultry, fresh fruits, and vegetables, and receive for them better prices than could be obtained nearer home.

Numbers of rest rooms have been established, especially at the county seats or in the larger business centers. The rest room has frequently demonstrated the need for a demonstration or community kitchen.

#### PURPOSE AND PLAN OF HOME-DEMONSTRATION WORK.

The object of home-demonstration work is the fullest and finest development of women and girls through the use of all of the many resources of the farm and the farm community. The largest possible number of rural home makers receive direct assistance in problems of production, conservation, and utilization of food, and in the preservation of health and prevention of disease; marketing of home-grown products; making, purchasing, and using labor-saving equipment; home management; child welfare; selection, making, and conservation of clothing; beautifying the home buildings and grounds; developing of community enterprises, including canneries, drying plants, curb markets, rest rooms, etc.

Considerable attention has been given to social enjoyment and recreation, as well as to general improvement of conditions in the community. It has been found most desirable to follow a well-defined program, but all along the line home-demonstration agents find hundreds of opportunities to give advice and make suggestions which lead to better living.

#### RESULTS.

During the last year the 15 Southern States had 20,323 clubs of rural girls and women, with an enrollment of almost 500,000 members. Of these, 8,396 were girls' garden and canning clubs, with a membership of 179,913; 5,102 were women's home-demonstration clubs, with an enrollment of 93,562 members; 947 were clubs for negro girls, with an enrollment of 33,944; 1,047 were clubs for rural negro women, with a membership of 38,036. There were in addition 5,496 poultry clubs for girls, with an enrollment of 47,701 members; 1,114 poultry clubs for women, with a membership of 23,015; 2,146 girls and 6,829 women enrolled in butter making; 3,567 girls and 7,272 women enrolled in cottage-cheese making; 43,199 women and girls were enrolled for special demonstrations in the introduction of new fruits and vegetables; and 1,490 negro girls and women doing special work in poultry.

Owing to the cutting off, July 1, 1919, of the emergency appropriation, practically all urban work had to be abandoned, and in many cases assistant county home-demonstration agents were dropped from the rolls or transferred to separate counties. Unorganized counties which during the war had had the benefit of help of emergency agents were left without any one when these special funds were with-

drawn. This accounts for the marked reduction not only in number of clubs and enrolled membership, but also in the production as well as conservation of food. Another factor that must be considered in this connection is the reaction that came after the armistice was signed, which led to a great letting down in activity, especially in production of food. If the figures for the past year be compared with prewar figures, however, it will be seen that in the Southern States there has been a steady, normal growth in the home-demonstration work. There has been a gradual increase year by year in the amount of State and local funds appropriated. This indicates the growing appreciation of the home-demonstration work among the people who are receiving its benefits.

As heretofore, food production was stressed, since it not only adds to variety in the family diet but enables many girls and women to add to their income. The reports show that 4,766,836 pounds of fruit and vegetables, valued at \$410,136, were used at home or sold fresh. The food, including fruits, vegetables, meat, poultry, and fish, canned or otherwise preserved, during the year had an estimated value of over \$12,000,000.

Another important part of the work was that concerned with the utilization of food and the improvement of the home dietary. It included demonstrations and instructions in the home use of fruits, vegetables, eggs, milk, and milk products, improved methods of bread making and other forms of home cookery, and various other related subjects.

The agents report a remarkable increase in enrollment and interest in poultry work. Better breeds of poultry, early hatching so as to have hens ready for winter laying, better feeding and housing of birds, production of infertile eggs, and preservation of eggs in water glass were the points most emphasized.

Instruction in sewing is incidental to other lines of girls' club work. Attractive uniforms for canning work, for gardening, and even for dairy and poultry work are made for the girls. They also receive help in preparing dainty articles for the home, such as luncheon cloths and napkins, while a very special feature of the past year has been the making of articles for the girl's own room—curtains, dresser covers, centerpieces, etc.

With women, sewing as applied to the conservation of clothing was a most absorbing topic. This work included the study of textiles, selection and care of clothing, and making or remodeling of garments. The work in the care of clothing has naturally called forth greater interest in proper methods of laundering.

Undoubtedly the newest phase of home-demonstration work is the beautification of the home, both within and without. During the year just completed this has created a demand for assistance in the planning of new homes and in the remodeling of others: in the rearranging of kitchens, especially for greater convenience. It has led to the installing of water, and heating and lighting systems; the introduction of both homemade and purchased labor-saving devices; and the improvement of the home and adjacent buildings, by the planting of lawns, flowers, shrubbery, and trees.

The home-demonstration program includes work with negro girls and women. Under the supervision of the white home-demonstra-



tion agents the negro agents are obtaining excellent results in food production, preservation, and utilization, in sanitation and health, in home industry and thrift, and in home beautification.

#### BOYS' AGRICULTURAL CLUBS.

Boys' club work in the Southern States has had one of the most trying years in its history. The discontinuance of the emergency appropriation, coupled with the loss of war activity stimulus, reduced paid and voluntary leadership to a marked extent. However, the 1919 enrollment was 158,738, exceeding the prewar enrollment by more than 40,000. This includes negro boys in the so-called "farm makers' " clubs. The products of the regular club work had an estimated value of over \$8,000,000. The average yield per acre of corn grown by club members was 48 bushels, while the average for the Southern States was 21 bushels.

The organized agricultural club, composed of club members who conduct various demonstrations, is rapidly evolving into the community club in which all community interests participate. County prizes are offered for community effort and rivalry between clubs causes community spirit to run high. The local boys' club judging team continues to be an effective means of stimulating local pride, each community desiring its team to win at the county fair and have the honor of competing at the State fair.

The county encampment and short course have been two of the greatest factors in keeping club interest at a high pitch, and have been very effective means of giving instruction in various useful lines. Wholesome entertainment is encouraged at the camps, and when the club members return home they are fitted to lead in much-needed recreational activities in the rural communities. Club members are selected at the county encampment to attend the State encampment or short course usually held at the agricultural college. Many who receive instruction at these meetings are inspired to seek a college education.

#### EXTENSION SPECIALISTS.

Extension specialists attached to the agricultural colleges have rendered excellent service in assisting the county agents and county home-demonstration agents in solving special problems arising in their territories. The necessity for a reasonable staff of well-trained specialists to assist county agents in handling unusual problems such as the growing and marketing of special crops, the control of diseases of plants and animals, use of fertilizers, dairying, poultry, general live stock, and marketing, is thoroughly recognized. Specialists do not usually work independently except in territory where there is no county agent, their chief function being to instruct, advise, and assist the county agents. As a rule, definite programs of work, in cooperation with the county agents and approved by the director, are followed so as to thoroughly correlate the work of the specialists and the county agents.

Subject-matter specialists of the Bureau of Animal Industry, Bureau of Plant Industry, Bureau of Entomology, Bureau of Markets, and the Office of Farm Management cooperated in extension work in the South during the year.

## NEGRO WORK.

In some of the Southern States more than 50 per cent of the rural population is composed of negroes. It is obvious that in any scheme of agricultural education designed to improve the average agricultural practice they must be reached. Without exception, white agents have, as far as possible, assisted and advised negro farmers, whether tenants or owners, the same as white farmers. In their reports no distinction is made and it is impossible to accurately state the total number of negro farmers who have cooperated with and been assisted by the agents, but the number has unquestionably been very large. Many of the best demonstrations along all lines have been carried on by negro farmers under the direction of the white county agents.

In certain sections where a very large proportion of the rural population is composed of negroes, local or assistant agents of their own race have been employed.

At the close of the fiscal year there were 158 negro demonstration agents and 74 negro women agents so employed, with 2 negro field agents.

In this work the department and the State agricultural colleges have as a rule cooperated with the negro agricultural colleges.

Some striking results have been secured. The work has been very effective, particularly in stimulating the production of home supplies, especially the home garden, in securing the adoption of better farm methods, and in educating the negro farmers to the importance of better live stock, the use of improved implements, and better sanitation and living conditions.

During the year three conferences were held to study the negro work and plan ways for more effectively reaching and helping the negro farmers. The conferences were held at Hampton Institute, Virginia; Tuskegee Institute, Alabama; and Prairie View Normal College, Texas, and were attended by Washington officials of the States Relations Service and the State extension directors and negro leaders, both men and women, in the three groups of States.

Successful extension courses for negro farmers and their families were held in several of the States for the first time this year in connection with the negro agricultural schools. The responsible negro leadership in the South is cooperating with the extension work more effectively than ever before, and real progress is being made in interesting the negro farmers and their families in better agriculture, better schools, and improved living conditions on the farm.

## NEEDS OF THE WORK.

The outstanding needs of the extension work are better qualified men and women for the service and more money for the support of the work.

It is becoming a very difficult matter to find men and women qualified both by education and by practical experience to fill positions as county agents and county home-demonstration agents. The agricultural colleges and colleges for the training of women are beginning to realize that extension work is a special field requiring

special training. A few of the colleges in the South have already put on or are preparing to put on special courses designed to fit the students for this field of work. The educational requirements of the county agents and county home-demonstration agents are higher than ever before and only thorough technical training will meet the need. While this is true, it has been the experience of the extension divisions that practical experience is equally as important a qualification for county-agent work. It is becoming increasingly difficult to retain in extension employment the men and women who have demonstrated their fitness for this work because of the competition from business and farming interests paying much higher salaries than are paid in extension work. County appropriations in the South, in a great many instances, have been greatly increased this year in the effort to secure and retain the right kind of men and women, but the need for more money, both to extend the work and to give better compensation in the way of salary and expenses to the workers, is urgent.

#### OUTLOOK.

Extension work in the South is on a solid basis of popular approval, as conclusively shown by the largely increased local appropriations for the support of the work and the cooperation and support of farmers, bankers, and other business men in the club work and other extension activities. Organized community effort in cooperation with the extension divisions of the colleges and the department is becoming more general everywhere and is more readily secured than ever before. Indeed, one of the outstanding results of extension work has been the education of farmers in cooperation.

To meet the demand for advice and assistance in cooperative marketing of farm products and cooperative purchasing of staple farm supplies the extension divisions will be compelled to give more attention than ever before to this phase of the work.

The boys' and girls' club activities have grown in importance and influence and command the hearty cooperation of bankers, business men, and citizens generally.

The work with the rural women in home improvement and home economics is growing rapidly and is assuming equal importance with the other major lines of extension activities.

Extension work has now its greatest opportunity for service, and the assured outlook is that with adequate support it will continue to grow in power, influence, and usefulness.

#### OFFICE OF EXTENSION WORK IN THE NORTH AND WEST.

C. B. SMITH, *Chief*.

#### GENERAL REVIEW.

This office has charge of the extension work in the 33 Northern and Western States. During the year attention was given especially to the strengthening of work already in progress rather than to the starting of new lines of work.

*The county-agent work*, which was so rapidly expanded during the war, obtained such a firm foothold in the good will of the farmers



that the withdrawal of a large portion of Federal financial support did not seriously affect the work, the farmers and county governments meeting the situation with locally contributed funds. There are still approximately 400 counties needing agents to complete the system throughout the North and West.

*The home-demonstration work* has undergone extensive adjustment and stabilizing. In practically all of the States this is now being put on a definite county basis with local financial support and well-organized groups of women within the counties supporting the work. The year closed with about 220 counties thus organized with a home-demonstration agent in each county. With the experience gained in handling the work it should go forward now systematically until all the rural counties have such an agent.

*The boys' and girls' club work* is one of the most popular features of the extension work. It is being carried on by practically all the county agents and home-demonstration agents as an important aid in the work, while in more than 270 counties the work has so developed that it has been found desirable to employ county club agents who give their full time to it.

*The farm-management demonstration work*, which is in part financed by this office, had one of the best years since the work began in 1914 in the way of numbers of farmers reached and development of methods of doing the work.

*Local cooperation and support.*—The plan of conducting extension work in intimate contact with the people concerned was continued with the most substantial kind of cooperation and support. Under this plan the agents of the Federal Government and the State and the local people concerned counsel together to consider the needs of the community, to agree upon programs of work, and to select the local men and women who will conduct the demonstrations, the agents of the Government lending their support, but the people themselves doing the work, reporting upon results, and explaining the work to interested neighbors. There is thus being put into operation on a large scale one of the most satisfactory and psychologically sound systems of adult teaching for rural people ever put into effect in any country.

*Finances.*—The total funds available for extension work in 1919-20 in the Northern and Western States was \$8,901,800. Of this amount, the Federal Government contributed \$3,097,100, including \$489,800 appropriated directly to the States Relations Service for farm-demonstration work, \$127,200 from appropriations to other bureaus of the Department of Agriculture, \$1,736,100 under the provisions of the Smith-Lever Act, and \$744,000 from funds appropriated to supplement the regular Smith-Lever funds. As an offset to the latter two amounts the States contributed \$2,150,100. In addition, there was available from the States and colleges \$913,000, from county funds \$2,275,300, and from other miscellaneous sources \$466,200. These funds were used as follows: For administration, \$580,400; printing and distribution of publications, \$109,300; county-agent work, \$4,888,000; extension work with women, \$1,161,700; boys' and girls' club work, \$661,800; and extension specialists, \$1,500,600.

## COUNTY-AGENT WORK.

On June 30, 1920, 1,145 counties were cooperating with the State and Federal agencies in the employment of county agricultural agents, while 20 more counties were covered by 10 district agents. In addition there were 58 counties with funds available which were temporarily without agents while awaiting the selection of a suitable candidate, making a total of 1,223 agricultural counties being reached by either county or district agents. There were also 8 assistant county agents, 33 county-agent leaders, and 65 assistant county-agent leaders, making a total of 1,319 field workers employed on June 30, 1920. June 30, 1919, 1,106 counties were cooperating in the employment of county agents and 105 other counties were being covered by 45 district agents. While the number of agricultural counties covered did not materially change during the year, the growth of the work on the basis of local financial cooperation was most satisfactory.

In view of the very rapid organization of the work during the war the progress of the past year was most gratifying. This is particularly worthy of note when considered in connection with the heavy withdrawal of Federal funds with the expiration of the food production act on June 30, 1919. This was made up in part by the increase of supplementary Smith-Lever funds but in a relatively much larger part by increased appropriations from States and counties and by subscriptions from farmers who desired to see the work continued. Without the help of the farmers in securing grants from county commissioners and in voluntarily coming to the support of the work at this time it would have suffered a serious loss in territory covered, with consequent decreased confidence in the future of the work. Stimulated by the war emergency, county-agent work increased 100 per cent in the short period of 14 months and gained more in territory reached than it had in the preceding six years. That this hastily constructed emergency line should have withstood the "shock" of peace is a splendid tribute to the character of service rendered by the war-time county agents and the business sense of the American farmer in supporting trained, capable leadership.

## COMMUNITY PROGRAMS OF WORK.

The widespread development of community programs of work marks another great forward step in county-agent work during the fiscal year 1920. Throughout the 33 Northern and Western States leaders and agents have been successful in demonstrating the great worth of this method of organizing extension effort, and rural leaders have helped to bring community program making to a high development. As a result, community effort has been stimulated and a greater community consciousness aroused, with a consequent acceptance of greater responsibilities on the part of rural leaders.

The basis of successful effort is confidence, interest, and enthusiasm, and these are best developed in a small, local, or community group where frequent personal contact is possible. The community analysis of local programs has the advantage over county-wide program making in that the people who are working together know each other, while the work undertaken is more vital and the results more

easily forecast. Instead of delegates who may not know each other coming together from all over the county to work out a program, a few chosen representatives come together in the community to consider things from a community standpoint. These local leaders counsel together to determine what the local factors are that may limit profitable and progressive farming and satisfactory home and community life. When they determine these, they settle upon the outstanding problems and set a goal or standard of accomplishment for the community to be reached during the year and select from among themselves leaders to carry out the program. In the selection of these community programs the county agent and the other county extension agents who may be employed sit as advisors in considering the technical phases of the work and help work out a division of labor. They present to the community group information as to what help can be secured from the agricultural college, the Department of Agriculture, or other public institutions as well as the part they may play. Naturally such real counsel, such close planning, such sharing of responsibility must and does assure much better planned and directed effort and greater accomplishment.

#### DEMONSTRATIONS.

County-agent work is based on successful demonstration. This work was seriously interrupted during the war period and particularly so during 1918. The work then partook more of the nature of campaigns, such as those for increased wheat production, home gardens, corn production, hog raising, and the like. It is significant, however, that the year just closed witnessed a return of demonstration methods with perhaps increased emphasis. This is borne out by the following figures, which cover the crop years 1918 and 1919, respectively:

#### *Demonstrations, 1918 and 1919.*

Item.	1918	1919
Number of demonstrations.....	78,868	90,660
Number of demonstration meetings.....	33,001	55,465
Total attendance at meetings.....	677,653	832,681

These demonstrations involved almost every phase of crop and live-stock production. Worthy of special note are seed corn selection; seed corn testing; control of oat and wheat smut; disease of potatoes; standardization of cereal varieties; introduction of alfalfa, sweet clover, and soy beans; orchard spraying, pruning, and cultivating; cow testing for production; building of silos and feeding of silage; effects of fertilizer and limestone; extermination of rodent and insect pests; control of weeds; blackleg and hog-cholera vaccinations; poultry culling; and introduction of purebred live stock.

The results of the county-agent work show a strong tendency to return to normal, sound agricultural practices, with strong emphasis on what might be termed the economic aspects. Nearly 100,000 farmers were assisted in starting farm accounts and 13,872 received assistance



from the agents in summarizing their accounts of the preceding year and in studying the profits and losses of their business. The agents assisted in the organization of 1,091 purchasing and marketing associations, and the total cooperative business conducted through farmers' exchanges and purchasing and marketing associations which the agents assisted in organizing reached more than \$60,700,000, with an approximate saving to farmers of nearly \$5,500,000. In addition, 254 farm-loan associations were organized and 11,939 farmers were assisted in securing credit for the purchase of machinery, seeds, fertilizer, and supplies. The labor bureaus started by the agents under war conditions were continued in most cases, and through these bureaus 118,891 laborers were secured for farmers.

#### TRAINING COUNTY AGENTS.

The problem of keeping men in county-agent work, of finding and training men for the work, is of greater importance than ever before. When county-agent work was started in the Northern and Western States, it was thought or rather hoped that the men appointed to the positions would remain in the work for a considerable period of years and that the work might be thought of as a career comparable at least with other professional work in agriculture. Experience has proven that this is desirable and that a good county agent becomes increasingly useful as his period of service is lengthened. It takes time to learn local conditions and gain the cooperation and confidence of farmers. A new agent must be able to work sympathetically with any organized groups of country people that he may find in the county and often to help in a more effective and complete organization for carrying on extension work. Most of all, the county agent must analyze and be able to correctly interpret the economic tendency in his county. The experience of those agents who have been in the work for five or six years has demonstrated the value of continued and concerted effort under uniform leadership to properly develop permanent agricultural programs. It is therefore a matter of some concern that the average period of service of the 798 men who have resigned from county-agent work since 1911 has been but a year and seven months, and the average period of service of the men at work now is less than two years. Of the 2,108 men appointed since 1911, 37 per cent have resigned.

The large turnover now that the work is approaching its maximum has created a serious problem for the State agricultural colleges, which must furnish the men to fill these positions. The magnitude of the requirements will be understood when it is considered that 95 per cent of the county agents now in the service are four-year graduates of an agricultural college, while an additional 4 per cent have had some agricultural college training. Based on the present turnover, it will take about 475 new men annually in the Northern and Western States alone to supply the places of agents resigning.

#### EXTENSION COURSES AT AGRICULTURAL COLLEGES.

In recognition of the need of trained men for county agents and other positions in the extension service, the agricultural colleges are making a beginning in the organization of extension courses. Colorado, New York, Oregon, and Wisconsin have begun such instruction

and several other State institutions have the matter under consideration. The subject is beset with many difficulties, but is receiving careful study and will doubtless soon find its recognized place in the college curriculum. While there is little of the undergraduate work that can be omitted, there is need that the prospective county agent or extension worker have a more fundamental training in such subjects as psychology, salesmanship, public speaking, advertising, writing for the press, and most of all general and rural economics and farm management. A few States, notably California, Indiana, and New York, have attempted to meet the demand for trained men by the appointment of assistant county agents. In this way men receive some practical experience with a good agent, and those who have made good as assistants become candidates for vacancies in counties. The agricultural college at Guelph, Ontario, has had particularly successful experience with an apprentice system. Under our conditions the financing of assistants has in most cases presented an insurmountable barrier. It is believed, however, that any system of undergraduate or graduate study for extension service that may be devised should be supplemented by some opportunity of field experience.

#### OUTLOOK.

The outlook for county-agent work is most encouraging. It has passed safely through a period of rapid expansion far beyond anything contemplated when the work was started and has successfully withstood the danger of serious reaction. It has also withstood the crisis of sudden withdrawal of funds, which, however, have been more than supplemented by local funds, so the net loss of counties with agents has been negligible. The work has "made good" with the farmers, and the agent's position of leader in rural affairs is no longer questioned. The problem is now one of gradual expansion of from 70 to 80 counties per year until the remaining 400 agricultural counties have been supplied with agents and of training competent men to fill the positions and keeping them contented and happy in the work.

#### EXTENSION WORK WITH WOMEN.

On June 30, 1919, 609 home-demonstration leaders and agents were employed in the 33 Northern and Western States. On June 30, 1920, there were 309 home-demonstration leaders and agents. Thirteen of these agents were located in cities. Although the force of workers was in one year reduced nearly one-half, the appropriations made by the local people for extension work with women increased 86 per cent, and every agent now located in city or county has been placed there in direct response to requests from the people, by whom they are staunchly supported in carrying out a program of work suggested by the needs of the locality.

#### ORGANIZATION.

With but one exception (Wisconsin) home-demonstration work was carried on in the counties during the year through a permanent organization of the people. In the majority of the States in the North and West this organization has been designated as the farm



bureau, and in this organization the interests of the home and women's part in community development have been coordinated with the work in agricultural development. During the year all the States have endeavored to develop community organization by uniting the interests of the men, the women, and the boys and girls in a county program looking toward the development of agriculture and home making, more convenient homes, lightened labor, a larger percentage of profits from effort and money expended, and better health and greater contentment of the people. Reports from 29 States show that 338 counties have been at work on activities of their own selection. Some of the counties which have adopted a program of work are without home-demonstration agents, but the women have organized local committees and appointed local leaders, and, with the assistance of State leaders and specialists at the agricultural colleges, are carrying on home demonstration among themselves until such time as funds may be available for the support of the home-demonstration agents.

#### RESULTS.

The more important lines of work carried on during 1919 included the home production of food, especially through gardening, poultry raising, and butter and cheese making; food preservation by canning and other means; food selection and meal planning; rural health, hygiene, and sanitation; making and remodeling clothing; home management and beautification; account keeping and budget making; and various community activities.

In the home production of foods over 31,000 gardens were planted, the produce from which was valued at \$422,000; over 3,200 poultry flocks were culled, with a saving in cost of egg production of \$103,150, and in this way, as well as by better marketing methods, the farm women's profits from poultry and eggs were increased. In a limited number of communities, where milk could not otherwise be disposed of economically, 103,926 pounds of butter was made, the estimated value of which is reported as \$49,707, and 395,718 pounds of cottage cheese was made, increasing the farm women's income \$69,035. The total value of fruits and vegetables canned or otherwise preserved was \$873,084. The estimated value of meats and meat products canned or otherwise preserved was \$317,940.

The more scientific use of food in the family diet was a feature of home-demonstration work in practically every State in the North and West. Outstanding results of this work were that more and better milk was introduced into the diet and the hot lunch was introduced with decidedly beneficial results into a large number of schools. The simple rudiments of caring for the sick in the home were taught in a number of counties.

It is estimated that the improved equipment and home conveniences introduced as a result of the home-demonstration work during the year resulted in a saving of over a million hours of labor to rural housewives, besides promoting their efficiency, convenience, and comfort in various other ways. The lessons of thrift learned during the war, as well as the high cost of materials and labor, attracted general attention to the subject of making and remodeling clothing and to the use of a budget system in apportioning household expenses.



## COMMUNITY INTERESTS.

A study of conditions in the individual home has broadened the horizon of farm men and women, with the result that they are taking a more active interest in community affairs and participating in increasing numbers in various community enterprises, such as community kitchens, canning and drying centers, milk stations, salvage shops, cooperative buying and selling associations, community rest rooms, and recreation centers.

## SURVEY OF FARM HOME CONDITIONS.

During the year a survey was made by home-demonstration agents in the Northern and Western States of conditions and surroundings of about 10,000 farm homes. The results of this survey were compiled and studied with reference to their bearing on the attitude of farm women and girls toward rural life, and are being used as a background for the development of home-demonstration work on the basis of meeting more completely the real needs of farm women.

## OUTLOOK.

There is a slow and healthy growth in home-demonstration work, with indications that during the present fiscal year a considerable number of additional agents will be called for and placed in counties. The indications are that the programs of work for 1920-21 will emphasize much the same projects as those carried on in 1919-20, with clothing, child feeding, household equipment, and poultry in the lead. Increased attention will be given to organization, with emphasis on developing community programs of work with definite goals, carrying on demonstrations under supervision in the home, securing more complete records of work accomplished, and training county and community project leaders. Special attention will be given to the further coordination of the work of specialists with that of home-demonstration agents.

## BOYS' AND GIRLS' CLUB WORK.

O. H. Benson, who had had immediate charge of the boys' and girls' club work of the office since its inauguration in 1912, resigned December 15, 1919, and was succeeded by George E. Farrell, formerly assistant in the boys' and girls' club work, but more recently secretary of the Hampden County Improvement League of Massachusetts.

State club leaders were employed in all of the 33 Northern and Western States during the year. On June 30, 1920, there were 66 assistant State club leaders and 273 county club agents, of which 186 were employed on a full-time basis.

## DEMONSTRATIONS.

The demonstrational value of boys' and girls' club work was increasingly apparent during the year. There were increasing evidences during 1919 of better live stock, greater yields per acre, and pleasanter and more comfortable home life following as a direct

result of boys' and girls' club work. This was due in a large measure to the intensive work of an increasing number of full-time county club agents. The greatest benefit, of course, has accrued to the boys and girls who conducted the demonstrations. In 1919, 310,115 boys and girls, as members of organized clubs, were afforded constructive farming, home making, and business experience that will be valuable in any vocation. Many also were established through club work in farming and related business on a profitable basis. The public team demonstrations given by club members have proved valuable to the community not only in spreading still further the influence of good farming and home making practices, but in developing the boys and girls themselves. During the year club demonstration teams gave 27,965 demonstrations to the public with an attendance of 534,973. It has been the aim to have the club demonstration teams use the farm costs secured through the farm-management investigations when discussing the various phases of crop and live-stock production. By this means sound farming practices and principles are early inculcated. The demonstrations conducted included work in feeding, management of farm animals, seed corn selection, poultry culling, bread making, home canning, garment making, and laundering, as well as other agricultural and home-making activities which were being promoted through the county extension organization.

#### ORGANIZATION.

In the very early development of extension work the relation of boys' and girls' club work to the county and community program of extension work as a whole was rather indefinite. In some cases county committeemen were appointed to advise with the club leaders. The next advance came in several States where the type of demonstrations conducted by the young people was determined by the needs of the community as expressed in the programs of work of the county organizations. The third step was taken when boys and girls received leadership from the same committeemen as did the adults. With this has come membership for the young people in many of the county organizations. There is a general feeling among members of farm bureaus and other county organizations that by the inclusion of the boys and girls the future permanency and efficiency of these organizations are assured and their present possibilities enlarged.

In 1919-20 the organized club, especially the standard club, played an important part in the county and community program of work and did much toward awakening community consciousness, first in the boys and girls, then in the community as a whole. There were 10,064 community leaders who took charge of these clubs voluntarily—that is, for each 30 boys and girls there was a local adult to direct their demonstrational activities. More of these clubs were established on a permanent rather than a seasonal basis than in any preceding year. Community, county, and State club leaders took an active and effective part in developing the community programs, coordinating all of the extension forces and promoting the various club activities.

## RESULTS.

Of the reported enrollment of 310,115 members in 16,395 clubs in 1919, a larger number (160,992) completed the required work and made reports than in any previous year. The estimated value of the products of the club members reporting was \$4,758,962. A large amount of work was done by club members who did not make final reports and is therefore not included in the above estimate. There were during the year 3,794 garden clubs, with 135,084 members; 2,458 canning clubs, with 32,656 members; 2,329 clothing clubs, with 31,419 members; 1,951 pig clubs, with 23,623 members; 1,645 poultry clubs, with 25,418 members; 710 potato clubs, with 10,790 members; 683 bread clubs, with 8,789 members; 564 corn clubs, with 7,345 members; 561 cooking clubs, with 11,540 members; 298 sheep clubs, with 2,988 members; 210 rabbit clubs, with 3,941 members; 187 baby-beef clubs, with 2,213 members; 56 farm and home handicraft clubs, with 961 members; 42 bean clubs, with 525 members; 40 sugar-beet clubs, with 332 members; 29 sorghum clubs, with 301 members; and 513 miscellaneous clubs, with 8,829 members.

## OUTLOOK.

In reviewing the work of the year, the outstanding feature of boys' and girls' club work is its closer coordination with the farm bureau as a distinct extension organization for the improvement of farm and home life. Farmers and business men are increasingly looking to boys' and girls' club work as the medium through which better practices in farming and home making may be secured and rural leadership developed. Appreciation of the work on this basis is evidenced by the employment of more full-time county club agents during the year than in any previous year. The indications are that more than 100 county club agents could be placed in as many new counties during the present year if the usual small financial encouragement from the colleges and the department can be given. This indicates a vigorous growth with an insistent demand from the people represented in the county extension organizations that aim to function to the fullest and to build permanently.

## EXTENSION SPECIALISTS.

During the year there was not only an enlarging of the work of the extension specialists connected with the State agricultural colleges but a clarifying of their methods of procedure. In counties where certain agricultural enterprises are dominant, the agents have been employed with a view to meeting the outstanding needs of such enterprises. In addition to the particular lines of work which might be undertaken by the county agent there were many others, such as fruit growing, poultry raising, plant pathology, insect control, marketing, and some of the more recent successful practices in the improvement of crops, soils, live stock, and fruit which required the assistance of the specialists from the extension division of the college. In fact, a comprehensive plan of work covering the various agricultural enterprises of a county has been in a large measure worked out by the assistance of the extension specialists from the



colleges. These specialists have also been able to learn, from the field standpoint, very definite needs as to investigational problems, which are transmitted by them to those in charge of such work at the experiment stations.

There has been a rapid change in the personnel of the force of extension specialists as well as of the county agents, but the development of plans of work within the county on which both specialists and county agents were working has contributed to the stability and the continuity of the work in spite of the shifting of the forces. Many of the State specialists are also finding that the agricultural needs of the people are being indicated by well-defined groups of counties or regions, and into such regions the specialist has been directing his efforts toward the accomplishment of measurable results, to the end that there is a conservation of effort and a greater number of people following successful practices.

Several of the bureaus of the department have employed persons whose chief interest is the extension of such information as the department has to transmit to the States and who, in many instances, cooperate with the States Relations Service in making a study of the extension subject matter organization within the State and the methods of extending the teachings of both the agricultural colleges and the United States Department of Agriculture. Specialists of the Bureau of Animal Industry, Bureau of Plant Industry, Bureau of Public Roads, Bureau of Entomology, Bureau of Biological Survey, and Bureau of Markets cooperated in this work.

Weekly conferences of the department extension specialists were held during the year for the purpose of bringing about a clear understanding as to the problems needing attention, for the discussion of extension methods, and for consideration of ways and means of carrying the results of the investigational work of the department to the extension specialists in the States and to the county agents in the development of their plans of work. These conferences have done much to bring about a better understanding and to develop efficient cooperation.

#### FARM-MANAGEMENT DEMONSTRATIONS.

There was normal development of the farm-management demonstration work during the year. Twenty-seven of the 33 Northern and Western States had farm-management demonstrators.

Special stress was laid during the year upon the promotion of accounting schools, since larger numbers of farmers can be reached by this method. Special farm account books have been devised for the purpose of aiding the farmer in studying his farm business, and 227,875 have been distributed by the agents, by bankers, or by other means. The county agents report 30,255 farmers who kept accounts throughout the year. The farm-management demonstrators report aiding 9,134 farmers in summarizing their accounts, while the county agents in 451 counties report aiding 13,872 in summarizing such accounts. The accounts are made the basis for studying the strong and weak features of the farm business. In many cases farmers have indicated a desire to study particular enterprises on their farms, such as the cost of growing sugar beets or producing milk. In 1919, 737 farmers were aided in keeping records of this

character, and 238 county agents report a total of 4,402 farmers who made profitable changes in their business as a result of their record-keeping work.

The work of the demonstrators was expanded during the year to include farm leases, farm-management exhibits at State and county fairs, and the development of farm-management clubs in a number of agricultural high schools. During the year special instruction was given to 1,053 local leaders of farm-management demonstrations; 486 accounting schools were held, with an attendance of 9,980; and 1,187 general farm management meetings held, attended by 37,342. In addition 157 short courses in farm management were held, attended by 7,498 persons.

As extension work develops it becomes more and more apparent that accurate records of the farm business properly interpreted are a vital factor in its progress. There is needed also the development on a substantial basis of an increasing number of farm-management departments for research which may serve as a basis for more effective extension work within the State.

#### OFFICE OF HOME ECONOMICS.

C. F. LANGWORTHY, *Chief.*

While pursuing the same general lines of work as in previous years, the Office of Home Economics to a limited extent enlarged its work in kind and degree. Particularly is this the case with the experimental studies of food preparation and similar problems, the object of which is to secure a more economical use of material, labor, and fuel in preparing food for the family. The technical studies with the respiration calorimeter have been continued. The family clothing, house furnishing, and general housekeeping problems have also received attention. Housekeeping involves a great number of operations, and economy of time and material, particularly in processes often repeated, means in the end a considerable saving of effort and money. This fact has been kept in view. Saving food or fuel, and making it possible to prolong the period of usefulness and enjoyment of equipment are important matters. So, too, are good methods for cleansing and for general care of the home, for they mean less labor and lessened expense.

The experimental kitchen has added materially to its equipment and to the topics studied and has also, as heretofore, given much attention to standardized methods of study in cooperation with workers in the agricultural colleges and elsewhere, in order that with knowledge of the work others are doing and with uniform methods for working and for recording results the total output of reliable data on the right use of foods may be increased. The nature and results of the work may be briefly outlined as follows:

1. Studies of bottle yeasts for home bread making have been continued, particularly with regard to the effect of different amounts of salt and of different storage temperatures upon keeping quality.

2. Studies in fuel conservation have added to the fund of data available for the discussion of top burner and oven cooking with gas as fuel. The insulation of ovens and other such cooking equipment has been found to be a practical way of effecting a material saving. The relative merits of directly and indirectly heated ovens have been studied. A study to determine the optimum

pressure of manufactured gas for best economy of both gas and labor in the household has claimed considerable attention. The relative merits of different metals and other materials for kitchen utensils have been considered and should receive further attention. One very significant development of this work is the study begun in cooperation with the Bureau of Mines of the Department of the Interior of the domestic use of natural gas by methods and equipment which will help to conserve this natural resource—an exceedingly important matter because of the rapidly disappearing supply.

3. In the studies of home canning, fruits, vegetables, meat, poultry, and fish products have been used to learn the influence of different environmental factors and variations in method of canning upon quality of the final product. These products, which include more than 1,500 cans and jars, are stored for a period comparable with ordinary home storage and are examined at frequent intervals both in a bacteriological laboratory and by judges with some experience in scoring canned products for excellence of quality. It seems clear that climate and other environmental factors must be given greater consideration than has heretofore been the case when instructions for home canning are issued. This is of special importance with such vegetables as asparagus, green beans and peas, corn, and okra, some of which may be suitably canned at home by water-bath methods, others of which should not be attempted under the trying conditions of a hot climate unless a steam-pressure cooker can be used. A considerable number of studies have been undertaken with non-acid vegetables to determine the effect of adding vinegar on the length of time required for processing. The rate at which heat penetrates different kinds of containers and different sorts of animal and vegetable tissues under varying conditions is also being studied. Such studies must be further continued in order to arrive finally at conclusive general deductions. One conclusion reached is that home canning, despite failures in individual instances, is in the main successful, and that this method of conserving our food supply merits the confidence placed in it.

4. The studies of dried fruits and vegetables have been continued, and as a result a paper, *Recipes and Methods of Preparation of Dried Fruits and Vegetables*, has been written for the use of the extension offices.

5. In the jelly-making work several processes for making pectin at home from apples and the peel of citrus fruits have been studied, and also the use of this pectin of home manufacture and of commercial pectin, with fruits lacking it entirely or with those having only a low pectin content. Mention may be made, too, of a comparison of cane and beet sugar for jelly making, in which equally good results were obtained, and of the use of malt sirup, which made a good jelly when used to replace half the sugar required.

6. An absorption of fat in frying greater than is necessary for good quality involves not only difficulty in digestion of the product, but also needless expense, and should be avoided by housekeepers as well as by commercial bakers, who are usually quick to realize that a small saving in each article cooked means in the end a large total. The experiments along this line (more than 250 tests) have given useful results which the housewife can apply. Contrary to general opinion, it has been found that the use of eggs in batters like fritters and doughnuts involves high fat absorption. Recipes can be given which insure a good quality of product without needless fat absorption, and this means a saving of material which means a saving of money, and also improved health in some instances at least.

7. At the request of the Bureau of Animal Industry a number of commercial fats made for cooking purposes were studied. Following this tests were made with a number of other shortening fats, including lard, butter, and several common manufactured products. It appears that the successful use of fats in cake and pastry making and the manipulation to be followed when incorporating them in batters and doughs is related to or determined by the "graininess" of the fat. "Graininess" is a name indicating the size of the crystals formed when cooling melted fat, the number and length of the crystals influencing decidedly the distribution of the fat when it is mixed with the other ingredients.

8. The work with meat has included studies of the qualities of different grades and classes of beef and their preparation for the table. A report of the results was given to workers in other branches of the Government service who were interested in the use of the cheaper cuts of meat by the average housewife. For the Bureau of Biological Survey a study was made of the food



value and cooking of rabbits, and the data obtained have been incorporated in a Farmers' Bulletin.

9. Work not previously mentioned has had to do with factors which influence the temperature of coagulation of eggs in making various dishes. Increasing the proportion of sugar was found to raise the temperature of the coagulation point in making boiled custards. Acids, as in fruit juices or slightly sour milk, lower it. Water custards did not curdle on long cooking, and the addition of exceedingly small amounts of soda prevented or greatly delayed curdling in all custards.

10. Testing and standardizing recipes, though not a major project, has been done as the needs of the office have required, particularly for use in Farmers' Bulletins and the publicity work of the department.

11. Making results available to extension workers is an important feature of the experimental work, and besides other ways of doing this, lectures and demonstrations have been given to groups of State leaders of extension work and of State club leaders upon several occasions.

The studies during the year of the thoroughness of digestion of foods included experiments with cod-liver oil, Java almond oil (*Canarium commune*), and hydrogenated (artificially hardened) fats made from corn, cotton seed, and peanut oils, both blended and unblended; raw starches (potato, corn, wheat, arrowroot of two sorts, rice, canna, and cassava); shallu, a cereal grain of interest in some localities, in the form of mush and bread; India buckwheat (*Fagopyrum tataricum*) flour; pie crust; and opossum meat. Artificially hardened fats were found to be as well digested as other fats of comparable melting point. The raw starches, in a sort of frozen pudding made with milk, were eaten in quantity and were very well digested, particularly the cereal starches, which were completely digested.

Such work as this is of scientific and technical interest and is of value also for the discussion of every-day dietary problems. Noteworthy is the fact that raw starch is well assimilated, a conclusion quite the opposite of general opinion. Shallu and India buckwheat in thoroughness of digestion were found to resemble closely such grains as Kafir. Reports on certain of these digestion experiments were published during the year.

Research work with the respiration calorimeter was continued in cooperation with the Bureau of Markets, to provide data fundamental to the handling and storage of food products. The specific heat and heat elimination of vegetables, fruits, and other commodities are factors which affect the amount and the cost, and, though little understood, are of great importance. These were determined by the use of the respiration calorimeter for freshly dug prime celery crated for market. The mean specific heat was determined over two temperature ranges—namely, 12° C. to 16° C., and 17° C. to 21° C. Heat elimination was determined at three temperatures—namely, 12° C., 16.5° C., and 21° C. The celery, which was in good condition, was then placed in cold storage for approximately one month, when its specific heat was again determined at 13.5° C. to 17.5° C. and its mean specific heat over this average temperature. During the experimental period of eight days the celery deteriorated rapidly and at the end was in an advanced stage of decay. The determination of gaseous exchange was difficult owing to the large elimination of water. The data obtained in these experiments, which are consistent, are of interest biologically as well as to the storage industry.

Another series of experiments was made with hens' eggs, the mean specific heat being determined over two temperature ranges, 12° C. to 15° C. and 15° C. to 19° C., and the heat elimination at three temperatures, 11° C., 15° C., and 19° C. The data obtained were of an entirely different order from those with celery, the eggs showing a small moisture elimination (due to evaporation) and almost no heat output, while the celery gave out much moisture and heat. The results of these experiments, like earlier ones with apples, provide definite data regarding matters which must be taken into account in storage. The best results in storage will be possible when such definite information supersedes empirical data, a fact appreciated by the storage industry in this country and elsewhere.

During the year the large respiration calorimeter was thoroughly calibrated for little-known constants and much information collected which will greatly facilitate work not only at room temperature, about 22° C., which is that commonly prevailing in such experiments, but also at other temperatures. Its heat capacity was also measured, as well as other factors which aid in research and its interpretation.

The small respiration calorimeter was also reconstructed to adapt it to more accurate and convenient work on storage problems requiring other than room temperatures.

Because of the subject matter with which it deals, particularly that on food selection and dietetics, the Office of Home Economics has always stood in an important position between the investigator and the public, and its work is of vital importance in the everyday life of the people. Recent developments have made its position in this respect more significant than ever before, for food shortage has stimulated research and on the other hand has increased the need among housekeepers and teachers for immediately applicable facts about food. This need is not limited to those who can understand scientific and technical terms, and is often most pressing among those who must be taught in the simplest language or by means of pictures, diagrams, and models. For these reasons the office feels an increasing responsibility for interpreting the results of scientific investigation so that they can be understood by all. Its responsibility grows greater, too, as avenues for the distribution of information open up. Not only has the home demonstration and extension work of the department and the agricultural colleges grown, but such agencies as the Federal Board for Vocational Education and the Red Cross are standing ready to make use of and distribute material based on the department's work. The same is true also of many private organizations interested in home economics and in child welfare, particularly in problems of right feeding for health and normal development. The office has, therefore, given considerable attention to the preparation of graphic material, including photographs, models, and charts relating to food selection and combination, labor involved in household tasks, and other phases of home economics.

Owing to lack of funds only a limited amount of work has been done with clothing and textiles and with household equipment and its care. Of special interest is the study and standardization of materials and methods for cleaning and repair, chiefly of floors and floor coverings. The information thus obtained, together with that obtained through cooperation with the Bureau of Standards and

other experts, has been used in the preparation of bulletins on laundry work, on the selection and care of clothing, on the cleaning and care of the home, and on the care of floors and floor coverings, the object in all cases being to show both how a saving of labor can be effected and how a saving of money can be made possible by prolonging the period in which a garment or an article of household equipment can be kept in good, usable condition. The data have been of much value also for discussion of household thrift, for publicity work of the department, for summaries for extension workers, and similar uses. Extensive use has also been made of such subject matter in the widely circulated series of 20 United States Thrift Leaflets, which were a joint product of the Department of Agriculture and the Treasury Department, and in a Farmers' Bulletin dealing with thrift in the home.

The amount of work required in the preparation of the bulletins and other publications originating in the office was large. Since funds for printing professional papers were limited, a number of reports of experimental work carried on in the laboratories of this office were prepared for publication in professional and technical journals. In this way it was possible to record the progress of research in the digestibility of various foods, the results of various types of experiments conducted in the calorimeter, and data collected in the experimental kitchen covering a wide range of subjects.

Besides reports of experimental work and similar material, two new Farmers' Bulletins, one entitled *The Selection and Care of Clothing* and the other *Home Laundering*, originating in this office, were printed during the year, and a number of the older Farmers' Bulletins, dealing with the work of the office, were revised. In cooperation with the Dairy Division of the Bureau of Animal Industry a circular dealing briefly with the value of milk as food was prepared. Over 40 short articles were contributed by the office to the Special Information Service of the department and furnished to the newspapers through the Office of Information. These were designed to be of special interest to women in their homes and include such general subjects as the care and repair of clothing, household-management problems, household accounts, food selection, preparation, and preservation, and the general nutrition of the family. In addition, a number of brief articles have been prepared for the *Weekly News Letter*.

Various progress reports of work being carried on in the experimental kitchen were mimeographed in small editions and distributed to the field workers in home economics, it being a part of the cooperative program that such information be furnished as soon as available to the other branches of the States Relations Service. This policy of cooperation is also carried out between the Office of Home Economics and other bureaus, and reports of special investigations have been furnished to the Bureau of Chemistry, the Bureau of Animal Industry, the Bureau of Markets, the Department of Justice, and other Government agencies, as well as to a considerable number of teachers and investigators in the home economics field and workers in kindred lines of commercial activity.





## REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF PUBLIC ROADS,  
*Washington, D. C., October 15, 1920.*

SIR: I have the honor to submit herewith the report of the Bureau of Public Roads for the fiscal year ended June 30, 1920.

Respectfully,

THOS. H. MACDONALD,  
*Chief of Bureau.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### FEDERAL AID ROAD WORK.

During the fiscal year 1920 the execution of all classes of construction work has been greatly delayed by the most disadvantageous economic conditions which this country has faced in many decades.

Railroad congestion, strikes, and labor and material shortages, resulting in high prices of these essentials of construction, have combined throughout the country to delay work which had been undertaken, and to discourage the undertaking of any but the most important new projects. The high prices of labor and material have sent construction costs skyward, and the work which has been launched in spite of conditions has necessarily been curtailed to the limit of the funds available.

Highway construction has perhaps been more adversely affected than any other class of work. After the war there was a great public demand for the improvement of roads, which had been seriously damaged in many instances by the augmented traffic incident to the prosecution of the war. It appeared that the release of labor from war activities and the return of men from the military service would provide an abundance of labor. Indeed, it was thought, for a time, that highway work should be increased to provide employment for returned soldiers, if for no other reason. Highway programs were accordingly greatly expanded, and in accomplishing this result the appropriation by Congress of the additional sum of \$200,000,000 for Federal aid in February, 1919, played an important part.

The army of laborers which was expected to apply for the work did not materialize. On the contrary, there has been at all times a distinct shortage of labor to carry out the work planned, and wages during the past fiscal year have reached the highest levels attained in the history of the country. Whereas, in 1917, competent labor could be secured in various parts of the country for from \$1.50 to \$3 per day, the corresponding wages this fiscal year were from \$3 to \$5 for a shorter day's work.

In proportion to the demand there was also a pronounced scarcity of the materials of construction. Sand, gravel, stone, and cement, materials commonly used in road work, increased in price between 1917 and 1920 by from 50 to 100 per cent. Naturally, these increases in the costs of the essentials of construction have been reflected in the prices paid to contractors for road work. A comparison of the costs of several of the common types of roadway in the fiscal years 1917 and 1920, shows an average increase in the cost of earth roads from \$2,160 to \$4,100 per mile; sand-clay roads which in 1917 cost \$2,460 per mile on the average, this year have cost \$4,685. Gravel roads have increased from \$4,535 to \$7,250 per mile; concrete from a cost of \$21,165 to upwards of \$40,000 per mile; and a brick road which now costs \$55,000 per mile could have been built in 1917 for \$33,000.

In view of the fact that the funds available for road construction are largely limited by statute or by the returns from taxation, and on account of the high prices prevailing, a majority of the States this year have deliberately withheld work, the plans for which have been completed, until such time as they could obtain a greater return upon the expenditure.

No small part of the reason for the high contract prices is attributable to the uncertainty of rail deliveries of material. Contractors who have been induced to enter the highway field in larger numbers than ever before, and who have invested large capital in plant and equipment designed to expedite construction, have lost heavily by reason of the failure of the railroads to make deliveries of material in accordance with anticipated schedules; and they have advanced their prices on subsequent contracts in the attempt to recoup their previous losses and to provide against similar contingencies in the future.

Reports received from the district engineers of the bureau at the end of the fiscal year show that as against 141 Federal-aid projects which were regularly receiving shipments of sand ordered, there were 68 projects which were seriously handicapped by delay in the receipt of this material. As compared with 128 projects which were receiving orders of gravel regularly, there were 108 which were held up by failure to receive it according to schedule; and though 167 projects were getting prompt deliveries of cement, there were 172 which were delayed by the inability to get shipments of this important material on time.

In the spring of 1919 many thousands of open-top cars stood idle. As the season advanced, however, and highway work got under way car shortages developed here and there almost continuously, and several times during the season this condition was general. Road work was very seriously hampered, and many projects which could easily have been completed had materials been available were carried over to the 1920 construction season solely because of the delays incident to inadequate rail transportation service. In our endeavor to secure the maximum service from the available equipment, and to continue as much construction work under way as possible, close contact has been maintained with the Public Service Division and Car Service Section of the United States Railroad Administration. Much has been accomplished through this cooperation.



With a view to making use of the open-top cars which ordinarily stand idle during the early spring months, the State highway departments were advised to let construction contracts early, and contractors were urged to make early shipments, storing the materials for future use. This effort undoubtedly contributed to the fact that in the spring of 1920 there was little if any surplus of open-top car equipment, whereas in the spring of 1919 upwards of 250,000 open-top cars stood idle for a number of weeks.

With the return of the railroads to private control cooperative relations were established with the Interstate Commerce Commission and the Car Service Division of the American Railroad Association, in order to continue the work which had been carried on with the Railroad Administration. Everything possible has been done to assist the State highway departments in meeting their rail transportation difficulties. It is apparent that for several years the transportation of road building materials is going to be the limiting factor in our highway improvement program. It is imperative that the maximum possible service be secured from the available equipment. To accomplish this result the cooperation of the shipper, the contractor, the State highway departments, the Interstate Commerce Commission, the railroads, and this bureau is necessary. The bureau is shaping its organization so that it will be possible in the future to render greater service in this connection than it has been able to in the past.

#### IMPROVEMENTS IN METHODS OF ADMINISTRATION TO EXPEDITE WORK.

The administrative work connected with the approval of plans, specifications, and estimates, and the checking and passing of vouchers for Federal-aid work performed became so great during the year that every effort had to be made to devise and adopt administrative methods calculated to facilitate the work.

During the course of the year several administrative arrangements have been introduced which have much improved the operation of the law and made possible a degree of harmony in cooperation and an amount of completed work not before attained under the Federal-aid act.

1. The arrangement provided for in section 8 of regulation 5 that States may proceed with construction on recommendation of the plans by the district engineer has been extended to cover revisions of plans even when the revisions were not of a minor nature but involved additional Federal aid.

2. Arrangements for sectionalizing projects have been developed to a point where the widest possible latitude is given to the States in placing work under contract by sections and completing the sections independently of each other. At the same time the number of project statements and project agreements has been substantially reduced.

3. State representatives have been placed in every State where the amount of Federal-aid work done would justify such action.

4. Districts 1, 2, and 3 in the Far West were divided into six districts, numbered 1, 2, 3, 11, 12, and 13 for the purpose of improving the administration of the act.

5. Arrangements have been made for the use of preliminary construction surveys covering heavy items of construction which may be approved by the bureau before complete plans for the details of the work are prepared. This arrangement enables the State to begin construction at an earlier date than would otherwise be possible.

6. After consultation with the Solicitor of agriculture, it has been found possible in many cases to draft project agreements and submit them to the State already signed by the Secretary of Agriculture. This makes it unnecessary to return the papers to Washington for signature, and was done to enable the States to submit claims and receive payments of Federal aid promptly.

7. A separate division of the engineering force in the Washington office was organized to handle the Federal-aid vouchers submitted. The number some months rises as high as 400, and each one of them involves the usual monthly estimate of construction, often very long and requiring the most careful checking and scrutiny. Large possibilities of delay existed in doing this work, and every effort has been made to expedite it.

8. By an understanding with the States, claims for Federal aid are not submitted for amounts less than \$1,000. By this arrangement the number of vouchers has been reduced about 30 per cent below what they otherwise would be and the work of handling vouchers proportionately expedited.

9. Owing to the large number of incorrect claims for very small amounts, numerical errors in the pro rata and other purely technical details in vouchers which would ordinarily necessitate the return of the voucher to the State for correction, the practice has been adopted of using the 5 per cent retent uniformly made against the States to cover as many of these defects as possible.

#### FEDERAL-AID PROGRESS.

In spite of the untoward economic conditions, and attributable in no small degree to the improvements in methods of administration effected during the year, the amount of Federal-aid business handled, as represented by numbers of projects, was approximately 25 per cent greater during the single year than all previous work done under the act since 1916. An average of 139 new projects were received and approved monthly.

The amount of the appropriations made by the Congress which became available at the beginning of the fiscal year was \$95,000,000, \$20,000,000 of which was derived from the act of July 11, 1916, and \$75,000,000 from the Post Office appropriation act of February 28, 1919 (H. R. 13308). From this there was deducted the 3 per cent allowed by law for administrative purposes, and the remainder, or \$92,150,000, was apportioned among the several States. This amount was in addition to the \$77,600,000 previously apportioned for the fiscal years 1917 to 1919, inclusive, so that the total amount which has been apportioned up to and including this fiscal year is \$169,750,000.

During the year a total of 1,670 project statements submitted by the States were approved by the bureau, as compared with 1,316 projects approved from 1916 up to the beginning of the year. The projects approved involved 16,673 miles of road as compared with the 12,720 miles which had been previously approved; and the Federal aid requested on these roads amounted to \$109,830,366, which was more than twice as great as the total amount of \$54,714,219 requested during the three years 1917, 1918, and 1919.

Agreements with State highway departments were executed during the fiscal year to cover 1,286 projects, almost three times the largest number executed previously in any one fiscal year, and nearly twice the total number executed prior to the beginning of the year. The estimated cost of the projects covered by these agreements amounted to \$197,571,626, of which amount there was set aside in the Treasury \$85,906,556 as Federal aid. At the close of the fiscal year 1919 there had been executed 677 of such agreements, involving an estimated cost of \$56,418,763 and an allowance of Federal aid amounting to \$23,931,618. Thus, at the close of the fiscal year 1920 a total of 1,963 had been executed to cover projects involving 15,178 miles, at a total estimated cost of \$253,990,389, including \$109,838,174 of Federal aid. Of the funds apportioned, therefore, there remained at the end of the fiscal year an unallotted balance of \$59,911,826.

Under the terms of the Federal-aid road act the apportionments to the States for each fiscal year remain available for expenditure until the close of the succeeding fiscal year, but it is construed that funds covered by agreements are expended within the meaning of the law. Each State had a sufficient amount of funds under agreement at the close of the fiscal year to prevent its losing any part of the funds apportioned to it.

The fact that nearly \$86,000,000 of Federal aid was allotted this year indicates that it is only necessary to maintain the present rate to assure the allotment of the entire unallotted balance of \$156,911,826 before the end of the fiscal year 1922, which is the date on which the last of the appropriations will lapse.

At the end of the fiscal year there were 1,835 projects under construction, involving 14,940 miles and Federal aid to the amount of \$103,925,094. These projects were in various stages of completion. The Federal aid allotted for the completed work amounted to \$31,174,732. Many of the projects were more than 90 per cent complete; the average project was 30 per cent complete, the work done on them being roughly equivalent to the work required to entirely complete 4,500 miles.

In addition to this work done on projects still under construction at the end of the year, there were 292 projects, involving 1,677 miles and \$8,920,353 of Federal aid, which had been entirely completed. Including the projects under construction and completed at the end of the year, there were 16,617 miles of Federal-aid road which had been placed under contract, a mileage which exceeded the aggregate length of the projects for which formal agreements had been executed by 1,439 miles. This condition results from the ruling of the Secretary of Agriculture, which permits projects to be placed under contract as soon as the plans, specifications, and estimates have been approved in order to expedite the work.

Including the Federal aid allotted for completed portions of projects under construction and to projects entirely completed, the Federal money allotted for completed work up to the end of the year amounted to \$40,095,085. At the end of the fiscal year 1919 the amount allotted for completed work was only \$4,658,749, so that the Federal aid allotted to work completed during the year was \$35,436,336. These figures do not represent actual vouchers paid. They are compiled from the reports of the district engineers on completed work and represent the value of the finished work more accurately than the sum of the vouchers paid, because of the lag which exists between the completion of the work and the payment of Federal aid. The total cost of the work completed during the year, including the amount paid by the States, was approximately \$80,000,000.

The rate of expenditure is increasing rapidly from month to month as more and more of the projects which have passed through the preliminary stages go under construction. The expenditure of \$80,000,000 for the year will be greatly exceeded next year, but even this rate goes far beyond the rate of expenditure in the construction of the Panama Canal. The performance of the Government in the construction of the canal has been regarded the world over as a record-breaking achievement in respect to the dispatch with which it was carried out. The cost of that work, however, was only \$373,000,000,



and 10 years were required to complete it, the average rate of expenditure being therefore only \$37,000,000 per year or less than half as great as the rate of expenditure on Federal-aid roads this year.

Comparing the magnitude of the Federal-aid program with the entire highway program of the United States, the significance of Federal aid is indicated by the fact that the amount of Federal money allotted to projects actually under construction at the end of this fiscal year, namely, \$103,925,094, was only slightly less than the total expenditure of \$106,861,053 from State funds for highway construction during the calendar year 1919 as reported to this bureau by the States.<sup>1</sup> The estimated total cost of these projects was greater than the whole expenditure during 1919 by States and local governments.

#### LOCATION AND CHARACTER OF FEDERAL-AID ROADS.

The Federal-aid road act as amended requires that any road to receive Federal aid must be a rural post road, defined as any public road a major portion of which is now used, or can be used, or forms a connecting link, not to exceed 10 miles in length of any road or roads now or hereafter used for the transportation of the United States mails.

In addition to seeing that the roads for which aid has been requested by the States comply with this statutory requirement, the bureau has also made an investigation in connection with each project submitted to ascertain that the road in question is of sufficient general importance to warrant the expenditure of Federal-aid funds in its construction.

The Federal-aid funds will not be expended entirely for so-called national roads. A large part of the money will be expended in improving the roads which radiate from market and shipping points into the surrounding agricultural country, the class of roads which in the last analysis are most closely identified with the development of the country.

In many of the States, particularly those of the East which have highway departments of long standing, the majority of the trunk-line roads have already been improved. In these States Federal aid is given to assist in filling the gaps which remain in the trunk systems, and for the construction of the more important lateral roads. On the other hand, there is a decided tendency in the younger States of the West to utilize their apportionments of Federal aid on trunk-line highways of national importance. As an indication of the extent to which this policy governs, there was at the end of the fiscal year a total of 8,620 miles of Federal-aid road which had been approved, and which constituted parts of the several transcontinental trails, such as the Lincoln Highway, the Bankhead Highway, the Dixie Highway, the Jackson Highway, and others. This mileage represented 30 per cent of the aggregate length of all Federal-aid roads approved, and \$58,745,359, or 36 per cent, of all the Federal aid approved. Eighty per cent of the mileage in Indiana is included in one of these marked roads, 86 per cent in Nevada, 54 per cent in Arizona, 50 per cent in Washington, while in Pennsylvania and New York, which have already constructed most of the roads of this category, the mileage represents

<sup>1</sup> Based upon reports from all States except Florida and Louisiana.

15 and 17 per cent, respectively, of the whole mileage of Federal-aid roads. In thus referring to the mileage of our roads which is included in these selected routes, it is not intended to convey the impression that such routes constitute a desirable or complete system of national roads. Indeed, it is safe to say that no one of such roads is laid down at all points in the most suitable location. In many instances we believe that sections of our roads which do not fall on the lines of these routes, will better serve the transcontinental traveller than the selected routes, but in the main these widely advertised roads do follow the natural lines of travel.

In order to provide a more rational basis for coordinated work on the part of the States, the bureau, in conference with the advisory committee of State highway officials, has initiated plans for a Nation-wide survey of the roads of the country, and a classification of all highways in respect to their importance and character of service. The survey when completed will doubtless furnish the necessary data for the establishment of a classified system of highways similar to the French system.

Already the bureau is cooperating with the War Plans Division of the General Staff and the Corps of Engineers of the War Department in a study the purpose of which is the selection of those highways which are important from a military standpoint, though at the outset it is recognized that the highways which are required for commerce and national development are in general identical with those required for military purposes. This work, which has been undertaken by the War Department at the suggestion of the bureau, is being assisted in every way possible. The detailed studies are being conducted by the department commanders, and the bureau is supplying maps and necessary information relative to highways under consideration.

The recommendations of the several department commanders will be coordinated under the direction of the General Staff and furnished to the bureau as a complete report covering the highways of importance from a military standpoint in the United States. When received the recommendations in this report will be given careful consideration and will be taken up in conferences with the State highway departments with a view to expediting the improvement of these highways as a part of the Federal-aid program.

The requirement of the act that the construction of Federal-aid roads must be of a substantial type must apply with equal force in the desert of Nevada and the densely populated areas of New England, New York, and Pennsylvania. In considering types of construction which may be approved for Federal aid it has been impossible to apply fixed and definite standards because no standards can be found which will meet the variety of conditions presented throughout the country.

Without, therefore, setting up definite requirements of construction or stipulating that roads of a certain type or types only shall be constructed, it has been necessary to apply more fundamental considerations to determine the adequacy of roads proposed by the States as Federal-aid projects. The considerations applied in determining whether a particular project is adequate and of a substantial type may be grouped under four general classes.

The first class refers to traffic, and under this heading each project is considered with respect to:—

(a) The amount of traffic at present using the road.

(b) The nature of the present traffic, with special reference to the amount of heavy trucking.

(c) The probable future traffic which will use the road after improvement.

A consideration of the last item above naturally leads to the second group of data which is considered in approving a project. This group has to do with—

(a) The type of adjacent roads.

(b) The relation of the proposed road to the State road system.

Successful and adequate improvement of adjacent or contiguous roads frequently assists in determining what type will be adequate under traffic likely to develop; and the part which the new road will play in the general State system is further indication of the probable future traffic.

Because of abnormal conditions in the materials market during the past year and the difficulty of securing transportation facilities, many projects have been affected; but entirely aside from these abnormal conditions, which temporarily affect materials and methods of construction, a third group of considerations is applied in determining the adequacy of Federal-aid projects. The elements of this group are—

(a) The quality and kind of local materials available for construction.

(b) Peculiar local conditions affecting construction.

(c) Prevailing practice in highway construction in the State or locality.

It is frequently found that suitable local materials are so much less costly than better materials imported from a distance that the construction of a lower type of work with the local material is justifiable, and as it is important to develop material sources throughout the country on as large a scale as possible, approval of the use of local materials is not infrequently made for the purpose of encouraging local production. There are also occasional peculiar conditions affecting the methods of construction. For instance, in parts of the far West the entire absence of water along a right of way and the expense of piping an adequate supply for 20 or 30 miles makes the construction of any type requiring large quantities of water uneconomical, and under these conditions other types are approved which can be constructed without the use of large quantities of water. The local practice must occasionally be considered, because of the difficulty of securing contractors when unusual or strange requirements regarding the work are insisted upon. For this reason the prevailing practices of the State in certain details of construction are admitted as affecting the design and type of work.

The last group of considerations is of a more technical nature and is at the present time confined to the results of experiments and studies made by the bureau and believed to be applicable to a greater or less extent in determining the substantial nature of proposed pavements. These experiments have to do with the resistance of the commoner types of pavement construction to impact and to the effects of heavy motor truck traffic. Studies of soil conditions in progress under the direction of the bureau likewise furnish additional information which can be applied in determining whether the designs for bases and sub-bases of pavements are adequate.



With these several considerations in mind the initial decision as to the type of a particular road is made by the State highway department. Its decision is reviewed by the bureau after an independent study of the conditions, and the type of road finally decided upon is that type which in the judgment of the engineers of the State department and of this bureau is the most suitable under the circumstances.

The types of road selected and constructed in this manner have included practically all the well-known forms of construction from unsurfaced earth roads to high-class concrete, brick, and bituminous concrete roads. In point of mileage the low types of earth, sand clay, and gravel represent about 66 per cent of all the roads constructed: the intermediate types of water-bound macadam and bituminous macadam, etc., constitute only about 7 per cent: and the high types of concrete, brick, bituminous concrete, etc. (including a considerable mileage the type of which has not been definitely decided, but which will be surfaced with one of the higher types of pavement), involve about 24 per cent of the total mileage.

A hasty conclusion drawn from these statistics might make it appear that the Federal funds are being spent to too great an extent on roads of relatively unsubstantial character. On the contrary, the bulk of the money is being expended for roads of the high and intermediate type—60 per cent for the former and 9 per cent for the latter—and only about one-quarter of the money allotted has gone for the roads of the lower type, which constitute 66 per cent of the mileage. Not only, however, is the major portion of the Federal money expended for roads of the higher type, but the roads themselves are of distinctly higher type, in the average, than the roads constructed by the State highway departments.

The following table shows the classified mileage of roads supervised by the State highway departments during the calendar year 1919, as reported to this bureau by the several departments. In the parallel columns the mileage of the types of Federal-aid road is repeated for purposes of comparison. Percentages of each type and each class are shown for the Federal and State roads. It will be clear from an examination of this table that the Federal-aid roads are relatively more substantial in the average than the roads built under State supervision alone.

*Classified mileage of roads supervised by State highway departments.*

Type and class.	Federal-aid roads.			Roads supervised by State highway departments, 1919.		
	Miles.	Percentage each type.	Percentage each class.	Miles.	Percentage each type.	Percentage each class.
LOW TYPE.						
Earth.....	3,701	21.5	66.3	7,212	41.4	75.0
Sand-clay.....	1,721	10.0		843	4.8	
Shell.....	27	0.2				
Gravel.....	5,583	32.5		5,035	28.8	
Gravel (surface treated).....	355	2.1				
INTERMEDIATE TYPE.						
Water-bound macadam.....	342	2.0	7.0	1,446	8.4	12.0
Water-bound macadam (surface treated) ..	97	0.6				
Bituminous macadam.....	714	4.1				
Rock asphalt.....	51	0.3		945	5.4	
HIGH TYPE.						
Bituminous concrete.....	496	2.9	24.4			11.3
Concrete.....	3,308	19.2		1,375	7.9	
Brick.....	351	2.0		145	0.8	
Sheet asphalt.....	48	0.3		128	0.8	
Undetermined and miscellaneous.....	392	2.3		293	1.7	

*Summary of project statements approved and project agreements executed.*

Year.	Project statements approved.			Project agreements executed.		
	Number of projects.	Estimated cost.	Federal aid requested.	Number of projects.	Estimated cost.	Federal aid granted.
Reported for fiscal year—						
1917.....	23	\$1,845,434	\$846,152	6	\$547,092	\$224,717
1918.....	557	41,053,201	15,478,090	218	14,239,939	5,658,458
1919.....	736	91,495,798	38,664,397	454	41,631,732	18,048,442
Now reported for fiscal year						
1920.....	1,670	252,530,183	109,830,366	1,286	197,571,626	85,906,556

NOTE.—The figures here given for the fiscal years 1917, 1918, and 1919 are from the annual reports for those years. As projects are modified from time to time, a project occasionally withdrawn, etc., sums drawn from the figures here given will not agree with the figures shown in the larger tables, which have in all cases been corrected to June 30, 1920.

Project statements approved, by States, 1920.

State.	Number of projects.		Total estimated cost.			Federal aid requested.			Mileage.	
	To June 30, 1919.	Fiscal year 1920.	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.	Fiscal year 1920.	To June 30, 1920.
Alabama.....	51	21	\$1,839,922	\$1,204,298	\$3,044,220	\$912,348	\$602,150	\$1,514,408	312	461
Arizona.....	8	18	892,472	3,952,841	4,845,313	1,943,211	2,131,408	2,385,083	193	352
Arkansas.....	22	51	819,416	8,473,430	9,292,846	314,873	2,131,408	2,445,569	123	728
California.....	16	38	3,545,401	9,253,743	12,797,234	1,735,241	4,327,584	6,092,775	200	584
Colorado.....	13	45	3,752,758	2,532,305	3,283,083	1,735,379	1,232,669	1,600,048	209	334
Connecticut.....	4	6	1,634,840	1,634,840	1,634,840	700,220	700,220	700,220	145	36
Delaware.....	6	1	1,332,850	93,500	1,626,350	272,604	92,312	294,914	35	36
Florida.....	16	8	1,937,751	1,795,594	2,733,345	412,703	897,797	1,340,500	32	84
Georgia.....	74	74	4,986,681	5,919,075	10,935,756	2,304,220	2,431,797	4,785,974	118	185
Iowa.....	148	148	1,679,327	3,597,928	5,270,255	738,520	1,793,464	2,531,844	607	1,033
Idaho.....	9	26	1,093,757	3,753,952	16,779,789	6,164,240	1,967,453	5,131,683	135	422
Illinois.....	12	12	2,923,740	9,713,248	14,843,997	2,446,511	1,540,273	2,585,786	542	99
Indiana.....	11	10	2,123,545	14,368,629	16,873,174	2,813,716	6,746,904	7,532,710	249	381
Iowa.....	37	67	1,025,645	14,368,629	16,873,174	2,813,716	6,746,904	7,532,710	541	1,720
Kansas.....	25	29	8,059,057	11,121,816	22,448,983	1,513,254	1,081,159	5,594,383	290	616
Kentucky.....	13	15	1,121,816	2,479,892	3,604,708	539,074	1,205,059	2,648,468	115	258
Louisiana.....	22	24	1,822,661	3,983,635	5,806,105	707,516	1,943,352	2,648,468	317	534
Maine.....	4	1	1,812,283	3,983,635	5,806,105	707,516	1,943,352	2,648,468	115	153
Maryland.....	3	27	1,812,283	3,983,635	5,806,105	707,516	1,943,352	2,648,468	115	153
Massachusetts.....	128	11	2,450,363	3,973,658	4,593,044	306,441	1,332,482	2,965,085	4	30
Michigan.....	16	21	1,470,904	2,884,132	4,354,036	3,200,440	1,332,482	1,824,801	181	137
Minnesota.....	37	41	3,159,874	5,206,096	8,359,122	1,434,877	2,350,099	3,984,467	32	191
Mississippi.....	42	121	3,402,453	13,844,419	17,146,872	1,417,826	6,200,069	7,934,957	233	400
Missouri.....	30	85	1,036,583	3,171,460	4,208,044	449,293	1,381,163	1,843,358	700	1,270
Montana.....	10	10	2,409,572	9,733,882	12,143,454	897,730	1,111,133	3,608,853	257	504
Nebraska.....	39	50	1,030,632	4,282,685	5,313,314	463,468	2,125,314	2,638,952	203	937
Nevada.....	51	77	3,033,402	6,408,370	9,443,722	1,431,207	3,137,348	4,638,952	1,323	800
New Hampshire.....	23	7	1,475,294	973,149	2,448,342	730,451	434,688	1,492,539	1,775	3,008
New Jersey.....	46	66	1,873,408	6,972,680	1,848,178	437,740	2,593,130	2,940,423	243	137
New Mexico.....	9	16	1,793,120	6,515,546	8,343,666	424,243	2,593,130	2,940,423	66	108
New York.....	17	27	1,330,655	2,917,224	3,697,909	685,343	1,183,412	1,848,455	42	357
North Carolina.....	30	35	3,890,908	9,100,401	12,981,269	1,093,654	5,338,700	6,202,384	295	632
North Dakota.....	40	78	1,943,638	13,156,748	18,101,376	609,849	9,332,701	9,106,939	337	375
Ohio.....	61	102	1,912,810	3,250,382	4,163,302	433,506	2,715,015	3,753,551	357	1,204
Oklahoma.....	72	128	13,169,371	8,520,908	21,690,472	3,973,095	2,715,015	9,724,505	949	1,318
Oregon.....	28	28	1,603,370	4,506,392	6,109,762	770,331	2,109,316	2,900,947	242	628
Pennsylvania.....	11	13	1,878,063	4,442,981	6,321,044	897,952	2,143,816	2,690,313	159	251
Rhode Island.....	43	39	12,398,335	12,216,675	25,055,514	4,947,104	4,713,119	9,453,489	178	441
South Carolina.....	4	6	1,137,352	1,137,352	1,137,352	1,137,352	257,389	4,453,489	321	518
South Dakota.....	33	33	3,757,183	3,757,183	4,707,000	402,591	1,157,361	1,508,892	142	27
Tennessee.....	21	14	949,377	4,081,109	4,707,000	362,212	2,000,561	2,902,766	328	471
Texas.....	7	21	746,339	5,278,610	6,024,949	371,277	2,635,512	2,902,766	565	747
Texas.....	79	72	4,737,001	16,355,018	21,092,019	1,911,717	5,706,172	7,617,889	1,067	2,219



## Project statements approved, by States, 1920—Continued.

State.	Number of projects.			Total estimated cost.			Federal aid requested.			Mileage.		
	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.
Utah.....	10	9	19	\$1,219,665	\$5,019,619	\$6,238,284	\$609,833	\$2,429,029	\$3,038,862	327	252	579
Vermont.....	40	6	16	199,147	790,503	999,650	84,574	386,251	479,825	17	30	47
Virginia.....	10	23	63	2,303,026	2,409,660	4,712,686	1,133,087	1,198,975	2,332,062	196	135	331
Washington.....	32	33	65	3,448,333	3,887,637	7,335,970	1,632,766	1,831,800	3,464,566	197	156	353
West Virginia.....	45	48	93	2,339,462	2,867,975	5,207,437	810,437	1,267,149	2,077,586	134	191	325
Wisconsin.....	88	59	147	3,269,483	4,282,090	7,551,573	1,088,850	1,490,643	2,579,493	411	219	630
Wyoming.....	24	42	66	1,123,448	3,289,237	4,412,685	561,724	1,637,279	2,199,003	254	384	638
Total.....	1,316	1,670	2,485	2,133,774,568	252,530,183	384,916,820	354,714,219	109,830,366	163,841,504	4,12,720	16,673	29,319

1 Project withdrawn in 1920.

2 \$1,387,932 withdrawn in 1920.

3 \$703,081 withdrawn in 1920.

4 74 miles withdrawn in 1920.

## Project agreements executed, by States, 1920.

State.	Number of projects.			Total estimated cost.			Federal aid granted.			Mileage.		
	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.	To June 30, 1919.	Fiscal year 1920.	To June 30, 1920.
Alabama.....	33	29	62	\$910,227	\$2,760,806	\$2,671,033	\$455,113	\$1,326,850	\$1,781,972	222	187	409
Arizona.....	4	17	21	406,494	3,533,568	3,940,022	193,025	1,543,303	1,730,318	21	147	167
Arkansas.....	21	24	45	717,325	4,628,397	5,346,072	303,061	2,043,987	1,331,198	118	393	511
California.....	6	27	33	999,211	2,876,931	5,876,072	882,936	2,438,466	2,931,392	160	247	307
Colorado.....	2	39	45	634,063	2,363,419	2,917,452	322,002	1,128,902	1,450,904	120	94	216
Connecticut.....	6	2	2	404,839	2,149,326	2,534,165	181,073	800,730	981,823	13	43	56
Delaware.....	2	4	7	1,345,586	2,584,225	3,920,809	131,811	1,201,015	231,980	22	12	34
Florida.....	7	9	4	408,303	2,704,597	3,123,165	212,009	1,260,406	1,476,917	31	71	105
Georgia.....	28	50	78	1,942,119	5,581,531	7,323,040	602,342	2,564,406	3,466,748	308	283	593
Iaho.....	5	5	10	746,171	1,271,433	2,017,004	359,164	643,943	1,003,167	60	166	166
Illinois.....	9	41	50	1,815,664	16,433,515	18,246,179	311,747	8,173,936	8,987,673	65	461	526
Indiana.....	19	19	4	4,690,037	4,690,037	4,690,037	446,357	2,200,870	2,200,870	122	122	122
Iowa.....	15	28	43	133,736	10,905,427	11,043,163	129,585	3,223,585	4,675,842	230	333	563
Kansas.....	36	43	4	1,209,423	11,740,551	12,948,977	441,745	3,506,265	3,948,010	30	263	305
Kentucky.....	7	17	22	747,525	2,838,502	3,586,027	370,586	1,319,077	1,689,657	30	197	136
Louisiana.....	18	1?	30	1,156,154	2,073,139	3,229,253	514,595	1,041,037	1,555,692	163	178	341

Maine.....	10	12	667,171	1,529,053	2,196,224	284,040	772,788	1,056,828	28	45	73
Maryland.....	30	43	1,192,104	2,301,965	3,494,069	571,711	1,080,669	1,632,380	53	71	124
Massachusetts.....	26	34	583,979	2,815,105	3,399,854	280,884	1,319,587	1,900,471	24	76	100
Michigan.....	29	35	2,986,336	2,996,318	5,985,854	1,437,880	1,470,335	2,608,165	192	263	313
Minnesota.....	24	75	2,071,728	5,590,708	7,662,436	848,543	2,370,185	3,218,728	462	477	939
Mississippi.....	15	34	701,044	2,425,892	3,186,436	348,527	1,145,107	1,493,934	131	155	286
Missouri.....	8	44	644,807	6,445,040	7,089,847	246,778	2,802,315	3,049,093	72	299	371
Montana.....	4	41	73,391	3,170,882	3,244,273	36,695	1,547,673	1,584,368	21	255	276
Nebraska.....	19	47	1,672,348	4,199,722	5,572,070	785,652	2,024,024	2,809,676	558	692	1,160
Nevada.....	16	66	232,994	1,277,571	2,271,771	497,100	636,424	1,133,524	125	09	194
New Hampshire.....	14	62	271,944	1,112,885	1,384,539	135,950	555,652	691,602	24	75	99
New Jersey.....	5	13	827,711	2,709,447	3,537,158	315,879	1,016,810	1,332,689	25	52	77
New Mexico.....	8	16	670,407	2,135,035	2,806,342	335,204	1,067,967	1,403,171	103	155	258
New York.....	9	36	1,782,956	8,214,112	9,997,068	884,728	3,565,482	4,450,210	45	200	245
North Carolina.....	27	64	1,480,787	4,443,059	5,922,846	480,952	2,127,117	2,608,069	210	251	461
North Dakota.....	22	20	688,138	1,855,137	2,543,275	344,069	927,568	1,271,637	334	200	534
Ohio.....	20	67	4,287,738	10,731,759	15,019,497	1,327,993	3,594,590	4,922,553	136	307	443
Oklahoma.....	5	11	732,866	2,945,391	3,698,257	362,039	1,437,461	1,799,500	47	96	143
Oregon.....	7	21	733,756	4,112,586	4,836,342	362,056	2,067,615	2,429,671	64	231	295
Pennsylvania.....	36	43	7,429,224	11,378,728	18,807,952	3,214,485	4,780,348	7,994,853	177	231	408
Rhode Island.....	4	7	305,885	268,880	574,765	148,170	126,865	275,035	12	6	18
South Carolina.....	10	23	442,479	2,380,545	2,825,024	206,308	952,369	1,188,677	56	203	259
South Dakota.....	5	19	170,626	2,130,865	2,310,431	85,313	1,069,903	1,155,216	50	263	313
Tennessee.....	7	16	779,710	4,589,966	5,369,676	386,350	2,297,056	2,683,406	68	187	255
Texas.....	46	62	2,628,463	10,941,028	13,569,491	1,120,274	3,964,655	5,084,959	520	803	1,323
Utah.....	4	5	472,062	1,499,488	1,971,550	236,031	749,744	985,775	113	96	209
Vermont.....	7	9	206,283	893,734	1,102,017	103,142	447,866	551,008	13	34	47
Virginia.....	24	48	1,194,652	2,041,045	3,235,697	583,530	1,634,318	1,617,848	115	107	222
Washington.....	14	31	940,997	4,225,094	5,266,091	441,511	5,081,031	2,522,542	70	180	250
West Virginia.....	23	41	896,556	2,514,639	3,441,195	375,550	1,183,926	1,559,476	49	127	176
Wisconsin.....	60	62	2,285,682	4,246,901	6,532,583	747,902	1,458,464	2,206,366	266	235	501
Wyoming.....	7	34	522,900	1,520,169	2,043,069	260,614	760,085	1,020,699	76	218	294
Total.....	677	1,963	56,418,763	197,571,026	253,990,389	23,931,618	85,906,556	109,838,174	5,790	9,388	15,178

*Projects under construction and completed.*

States.	Projects under construction.	Miles under construction.	Federal aid under construction.	Total estimated cost under construction.	Per cent completed on projects under construction.	Projects completed.	Miles completed.	Federal aid completed.	Total estimated cost completed.
Alabama.....	39	252	\$1,239,358	\$2,702,260	40	16	98	\$275,431	\$673,381
Arizona.....	113	97	1,219,883	2,772,819	43	15	36	276,624	607,864
Arkansas.....	47	606	1,900,783	7,280,736	25	8	32	99,459	234,666
California.....	131	288	2,854,185	5,723,564	42	6	48	458,078	922,424
Colorado.....	140	211	1,432,472	2,884,544	30	10	37	186,005	384,780
Connecticut.....	13	27	433,103	993,973	13	1	5	53,000	148,694
Delaware.....	16	33	270,570	1,879,076	68	11	1	4,500	50,735
Florida.....	119	146	1,821,992	3,712,185	8	1	11	16,938	34,083
Georgia.....	180	655	3,866,484	8,743,637	28	6	18	171,188	350,153
Idaho.....	21	282	2,079,297	4,282,125	29	3	39	73,688	158,767
Illinois.....	1144	579	10,427,463	20,924,034	34	15	13	152,600	343,007
Indiana.....	118	121	2,041,030	4,703,179	22	1	1	20,707	41,416
Iowa.....	33	412	3,234,700	7,577,277	20	4	81	136,150	486,613
Kansas.....	137	285	3,909,832	12,149,449	23	2	2	31,869	85,130
Kentucky.....	21	127	1,423,560	3,415,282	25	11	6	100,000	200,000
Louisiana.....	30	373	1,962,747	4,133,940	29	6	53	179,324	449,918
Maine.....	11	47	669,399	1,397,101	3	12	19	213,898	427,756
Maryland.....	136	118	1,353,339	2,974,045	71	17	25	244,511	508,597
Massachusetts.....	124	80	1,283,468	2,886,158	1	8	25	301,909	591,288
Michigan.....	124	276	2,867,960	6,290,631	38	11	51	421,292	1,015,416
Minnesota.....	102	1,334	5,564,205	12,860,561	39	9	109	207,351	587,346
Mississippi.....	131	285	1,189,043	2,584,347	25	1	4	15,000	30,950
Missouri.....	123	232	1,525,439	3,506,408	9	2	10	72,604	162,013
Montana.....	148	377	1,550,659	3,682,275	27	2	(2)	45,793	91,588
Nebraska.....	168	1,147	2,831,696	6,136,791	44	2	9	64,400	227,885
Nevada.....	115	139	820,155	2,024,501	35	5	37	114,108	231,825
New Hampshire.....	59	76	511,986	1,061,363	50	21	24	159,114	325,977
New Jersey.....	115	68	1,209,491	3,183,142	39	3	9	122,929	347,987
New Mexico.....	110	90	584,486	1,190,392	50	15	59	278,202	594,526
New York.....	18	42	834,455	1,794,051	23	1	3	33,855	81,600
North Carolina.....	154	480	2,514,187	5,364,748	28	13	65	251,650	657,008
North Dakota.....	135	499	740,456	1,597,712	53	5	47	40,078	103,872
Ohio.....	168	353	4,023,537	10,234,237	25	6	38	413,100	1,346,101
Oklahoma.....	12	138	1,515,014	3,043,599	16	2	5	57,293	120,259
Oregon.....	31	391	2,749,027	5,757,932	26	8	59	397,290	796,724
Pennsylvania.....	169	469	8,728,532	20,268,844	24	19	88	1,473,134	3,307,252
Rhode Island.....	6	16	265,459	572,323	21	2	5	55,097	120,296
South Carolina.....	124	203	870,396	2,894,281	22	9	50	206,623	450,103
South Dakota.....	128	375	1,374,201	2,771,441	27				
Tennessee.....	20	244	2,183,620	4,874,189	6	1	2	25,937	54,738
Texas.....	179	1,077	3,982,711	11,674,345	30	15	156	283,518	750,592
Utah.....	6	176	678,307	1,570,741	27	1	9	30,670	61,340
Vermont.....	6	14	130,266	260,532	41	3	3	21,930	54,625
Virginia.....	152	261	2,081,594	4,380,855	38	4	17	74,589	161,252
Washington.....	51	249	3,058,753	6,457,394	46	16	88	552,080	1,176,512
West Virginia.....	188	277	2,358,674	5,489,055	28	4	10	29,730	82,723
Wisconsin.....	95	418	1,806,854	5,223,103	36	22	89	311,448	905,572
Wyoming.....	155	482	1,950,266	4,092,040	24	7	86	165,659	333,100
Total.....	1,835	14,940	103,925,094	241,977,217	30	292	1,677	8,920,353	20,878,484

<sup>1</sup> Projects and sections of projects under separate agreements.<sup>2</sup> Bridges.



Summary of types of construction involved in projects for which plans, specifications, and estimates have been approved during the fiscal years 1917, 1918, 1919, and 1920.

State.	Earth.	Sand-clay.	Shell.	Gravel.	Gravel-surface treatment.	Water-bound macadam.	Water-bound macadam-surface treatment.	Bituminous macadam.	Rock asphalt.	Bituminous concrete on stone base.	Bituminous concrete on concrete base.	Concrete.	Reinforced concrete.	Brick on stone base.	Brick on concrete base.	Sheet asphalt.	Undermined.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
Alabama.....	3,190	243,029		126,611		20,770		2,500			17,943	21,478				5,670	1,098
Arizona.....	12,707			130,693				53,770			1,277						
Arkansas.....	3,610			283,394		11,430					117,550						
California.....	4,080			135,260		21,410					15,706	106,370	81,489				
Colorado.....	79,580			111,119				19,010				36,165					
Connecticut.....												37,486					
Delaware.....		21,150						11,675				27,903					
Florida.....	57,433	460,441		73,663		0,289		41,588	2,750			9,480	63,108	6,212			
Georgia.....	110,810			55,510							5,750						
Idaho.....	25,223			0,164								67,694		0,350			4,550
Indiana.....											8,066	544,633		16,576			
Iowa.....	317,042			101,098							110,274	20,650		4,050			206,791
Kansas.....	15,754			86,080		4,527		33,392			101,018	0,761		66,830			103,960
Kentucky.....	43,998					14,998						12,998		3,892			
Louisiana.....	5,360		7,736	392,754		7,220		36,379									
Maine.....				25,612		39,574											
Maryland.....	5,590			10,870								18,890					
Massachusetts.....				2,310		3,240	5,019	35,436				107,742				2,010	
Michigan.....	11,634			100,326		23,141						39,475					
Minnesota.....	58,163	13,770		953,559							33,284	108,605		0,385			13,969
Mississippi.....	38,446			248,734							17,370	107,749					
Missouri.....	12,257			242,378				57,915				45,708					
Montana.....	54,793			188,230		5,000					4,590	86,076		3,526			12,370
Nebraska.....	1,037,621	146,676		116,228							0,522	14,034	1,416				13,953
Nevada.....	78,650			55,460								8,559		6,900			
New Hampshire.....				63,655		3,272		17,589				29,680					
New Jersey.....	15,258			3,381								77,215				2,613	
New Mexico.....				213,397		8,479						21,243					
New York.....	35,890	292,054		51,124				9,610				11,440	229,280				
North Carolina.....	476,971	3,500		54,100				28,406				72,807	1,080			1,782	
North Dakota.....																	
Ohio.....	27,410			56,263		48,138		97,402				88,596	50,063				34,881
Oklahoma.....	173,930			111,830		0,190		14,500				25,794		102,605			
Oregon.....						46,410						83,469		0,350			
Pennsylvania.....						0,090		7,892					386,342				
Rhode Island.....								8,726				6,690				31,991	35,905

*Summary of types of construction involved in projects for which plans, specifications, and estimates have been approved during the fiscal years 1917, 1918, 1919, and 1920—Continued.*

State.	Earth.	Sand-clay.	Shell.	Gravel.	Gravel- surface- treat- ment.	Water- bound mac- adam.	Water- bound mac- adam, surface treat- ment.	Bitu- minous mac- adam.	Rock as- phalt.	Bitu- minous concrete on stone base.	Bitu- minous concrete on concrete base.	Concrete.	Rein- forced concrete.	Brick on stone base.	Brick on concrete base.	Sheet as- phalt.	Under- ter- mined.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
South Carolina.....	79,033	318,051	.....	20,799	.....	.....	.....	3,030	.....	.....	.....	31,490	.....	.....	.....	.....	.....
South Dakota.....	20,466	.....	.....	288,173	.....	.....	.....	119,987	11,872	.....	.....	12,013	.....	.....	.....	.....	.....
Tennessee.....	216,433	.....	.....	41,437	.....	49,197	.....	14,165	.....	6,946	.....	57,923	11,993	.....	.....	.....	.....
Texas.....	134,880	46,867	19,556	674,596	326,786	14,049	20,490	.....	.....	.....	.....	29,410	.....	.....	.....	.....	.....
Utah.....	.....	.....	.....	44,850	.....	.....	.....	.....	.....	.....	.....	1,400	.....	.....	.....	.....	.....
Vermont.....	.....	.....	.....	33,615	.....	5,510	.....	6,380	.....	.....	.....	.....	.....	.....	.....	.....	.....
Virginia.....	.....	66,351	.....	45,679	.....	83,539	.....	28,548	.....	.....	.....	53,489	.....	.....	.....	.....	.....
Washington.....	14,795	.....	.....	185,362	.....	.....	.....	.....	.....	.....	.....	110,634	5,960	.....	.....	.....	.....
West Virginia.....	71,440	.....	.....	11,100	.....	2,000	4,827	47,616	.....	11,394	.....	60,995	5,228	12,389	.....	.....	.....
Wisconsin.....	181,293	36,436	.....	125,614	.....	9,120	.....	7,980	.....	.....	.....	139,234	0,944	.....	.....	.....	.....
Wyoming.....	135,949	55,957	.....	219,135	.....	2,158	.....	.....	.....	1,225	.....	13,000	.....	.....	.....	.....	.....
Total.....	3,701,295	1,720,916	27,292	5,583,023	355,305	342,386	97,359	714,411	51,001	124,491	371,413	2,533,695	774,556	97,267	253,824	47,980	391,572

*Summary of miles and types of roads for which plans, specifications, and estimates have been approved during the fiscal years 1917, 1918, 1919, and 1920.*

Type.	Mileage.	Per cent of mileage.	Total cost.	Per cent of total cost.
Earth.....	3,701	21.5	\$21,763,989	7.7
Sand-clay.....	1,721	10.0	9,854,570	3.5
Shell.....	27	0.2	296,801	0.1
Gravel.....	5,583	32.5	47,151,795	16.8
Gravel (surface treated).....	355	2.1	4,136,533	1.5
Water-bound macadam.....	342	2.0	5,258,779	1.9
Water-bound macadam (surface-treated).....	97	0.6	1,433,499	0.5
Bituminous macadam.....	714	4.1	16,669,782	5.9
Rock asphalt.....	51	0.3	1,978,293	0.7
Bituminous concrete.....	496	2.9	15,064,756	5.3
Concrete.....	3,308	19.2	120,629,308	42.9
Brick.....	351	2.0	15,725,494	5.6
Sheet asphalt.....	48	0.3	1,572,472	0.6
Undetermined.....	392	2.3	19,796,607	7.0

### SUGGESTIONS FOR FEDERAL ROAD LEGISLATION.

The original Federal-aid road act of 1916 embodied and represented the best thought of both the State and Federal road departments and presented the principles which, without the basis of practical experience, seemed at that time would prove the most successful in promoting the improvement of the public highways on a large scale. The plan of cooperation between the Federal and State Governments written into this law was not new. The same principle has been used most successfully by the Federal Government to promote worthy undertakings, and had already manifested its possibilities through several of the most important undertakings in which the Federal Government has assisted. For example, in order to insure the building of railroads, particularly in the newer and less developed regions of the country, grants of land were made to help finance the cost of construction.

Although the application of this principle of Federal aid was grievously misapplied in certain instances, nevertheless it is very probable that without this assistance the building of many of the lines would have been postponed for an indefinite period. So intimately related was the extension of transportation lines with the betterment of the country that it is difficult to estimate the full benefits that were secured from the public lands used as Federal aid to the railroads.

Again, the development of many institutions for higher education occurred only after grants of land had been made by the Federal Government to assist the States in establishing them. Following the Morrill Land Grant Act of 1862 a very large number of the leading educational institutions of the country were founded and their influence on agricultural and engineering advancement has been profound.

More recently, through the instrumentality of the same principle of Federal aid to the States, the extension and practical application of the most advanced agricultural science and practice have been made available to a very large number of the individual farmers through the county agents.

It is apparent that the Federal-aid principle as a plan of action has been highly successful in fields differing as widely as the building of



railroads and the promotion of education. In the latter case it has been successful in making available education to the individual varying from the most practical applications of agricultural science to the highest collegiate instruction.

Although the inauguration of the Federal-aid road program came at the most difficult period the country has faced in recent years, the results of the past year indicate a most successful application of this same Federal-aid principle to highway construction. When it is remembered that for the year ending June 30, 1920, project agreements were entered into between the Secretary of Agriculture and the State highway departments providing for the construction of 5,790 miles of road at an estimated cost of \$197,571,626, for which the amount of Federal aid allotted is approximately \$86,000,000, it is apparent that the States are meeting the Federal Government more than halfway in the program of highway construction which is now well started. The States have been more than generous in their support of the program. Where limitations on the cost per mile now carried by the Federal-aid law threatened to prevent necessary highway construction because of the prevailing high prices, the States have disregarded the 50 per cent participation which the law proposed and are largely meeting the advanced costs. In some cases the participation of the Federal Government may be less than half that contemplated in the original act.

The State highway departments have, in general, evidenced a spirit of cooperation with the Federal authorities that has placed the whole administration of the act upon a most satisfactory basis. There is every evidence that the Federal-aid plan of encouraging highway building is fulfilling its purposes to an even greater degree than might have been expected. Certainly the conditions which have prevailed since 1916 would have prevented the successful operation of any plan that was not fundamentally sound. Considering the Federal-aid act as it now stands as a partnership agreement between the Federal Government and the States, the recommendations of the State highway departments should be given the greatest weight in considering new legislation or modification of the law as it now stands. It must be remembered that roads are first of all local institutions, and that the greatest use made of the roads is by the people who are served directly by them. There are interstate and national uses which must also be considered, but these are so small a percentage of the total use that they are not entitled to preferential treatment except in very special cases. At the December meeting of the American Association of State Highway Officials, which is composed of the administrative and executive officers of all of the State highway departments, resolutions were passed embodying the following modifications and additions to the Federal-aid acts:

First. Additional appropriations continuing at the rate of \$100,000,000 per year for the building of post roads within the States.

Second. A modification of the present equal ratio of cooperation between the Federal Government and the States, whereby the portion of the total cost of the road projects borne by the Federal Government is increased in proportion to the amount of publicly owned land within those States more than 10 per cent of whose area is such public lands. In fixing the ratio of cooperation required from these public-land States the area of forest lands is considered as privately

owned lands on account of the policy which now exists of improving roads within the forest areas from Federal funds.

Third. That the application of Federal-aid funds be made to those highways which will expedite the completion of an adequate national highway system.

Fourth. That the Territories of Alaska and Hawaii shall be admitted to participation under the Federal-aid act in the construction of post roads in those Territories.

Fifth. That the appropriation for the building of roads in the national forests shall be continued at the rate of \$10,000,000 per year for a period of 10 years.

These principles having been developed through the experience of the State and Federal highway departments in the administration of the Federal aid road acts, it is believed that they are thoroughly sound and should be made a part of future Federal legislation on this subject.

The present law allows cooperative funds to be provided by the State or by subdivisions of the State, although the administration of State funds is in all cases through the State highway departments. In general the policy of allowing the full amount of the cooperative funds to be supplied through the local subdivisions is not entirely satisfactory, and it is believed that more satisfactory results will be obtained if cooperative funds are supplied in part through State sources. When a large local program is contemplated there is no reason why a portion of the cooperative funds should not be supplied through local agencies, as this helps to distribute the burdens of cost in those localities which receive the most immediate benefit. It is believed, however, that without regard to the policy which is followed in providing construction funds the maintenance required under the Federal-aid act should be carried on only by the State highway departments. It is already apparent that local subdivisions can not be depended on for the constant, painstaking maintenance that has become so highly necessary on our main highways with the greatly increased number and weight of the traffic units. It is believed, therefore, that any extension of the Federal aid funds provided for in future Federal legislation, which requires that highways built with such funds be maintained by the State authorities, should provide that the funds for such maintenance must be administered by the State highway departments exclusively. It is already apparent that, because of the present economic conditions affecting the building of highways, progress will not be as rapid for several years to come as could be desired. It is very necessary, therefore, to maintain in service those highways which, with careful maintenance, can be held up under present-day traffic, as well as to provide the best maintenance possible for the new highways which are constructed. The present plan of allowing maintenance funds to be provided by localities will not prove satisfactory in maintaining the projects which are built through the use of Federal aid, and this condition can be prevented if the maintenance funds are supplied by the State and administered through the State highway departments.



### NATIONAL FOREST ROADS.

The road systems of the national forests are closely allied with those of the States and the Forest Road Program may be looked upon as forming an integral part of the general road plan of the West. Due to the fact that the forest areas lie along the mountain summits, they contain the passes through which the important trunk highways must cross the mountain ranges, and as a consequence many forest road projects are links in important State and national highways. Within the forests are approximately 15,000 miles of roads which form connecting links for State and county highway systems. Over these roads the traffic from the communities adjacent to the forests must pass. The transportation of forest products, the protection and administration of the forests themselves, and the utilization of these national areas for recreational purposes are all dependent upon these roads. The improvement of these roads and the construction of a supplementary system of protection roads constitutes the national forest road project. Forest road improvement should keep pace with the general highway development in the West, and the closest study should be given the subject of correlation of road activities.

The forest road construction program has been affected by the shortage of labor and high prices and to some extent by the difficulties of rail transportation. Lack of materials and transportation have not seriously retarded the work for the reason that imported materials are not extensively used on the forest roads. Delivery of structural and reinforcing steel and of metal culverts has been slow and to some extent has hampered the construction work.

The lack of sufficient and suitable equipment mentioned in the report for the fiscal year 1919 has also retarded the work this year to some extent. Some excellent road-building equipment has been transferred to the bureau from the War Department, but unfortunately much of this was not received early enough to permit its use this year. Three steam shovels were obtained in time to be used several months on the Berthoud Pass and Mount Evans projects in Colorado. This equipment will remain on these projects for another season at least and will result in a more rapid completion of the work. Both of these projects reach an elevation of 11,000 feet, and labor is difficult to secure. The bureau still finds itself in need of considerably more road-building equipment in order to continue the program of construction and provide for a systematic plan of maintenance. Our more important needs for this work are small steam shovels, stone crushing and screening machinery, tractors, road graders, motor trucks of less than 1-ton capacity, light passenger motor vehicles, and shop equipment for repair purposes.

The use of War Department TNT on our construction work has been the means of effecting substantial savings in the cost of our projects. It has been found that this material is well suited for our purposes and contractors as well as our own superintendents are well pleased with the results obtained by its use.

It has been found necessary to expand our activities in the matter of handling work by department forces. The bureau has been reluctant to do this, but the lack of experienced contractors in some localities, the remoteness of our work, and the attendant difficulties



and uncertainties have often resulted in unsatisfactory prices under the contract system. Every effort is made to interest reliable contracting organizations in the work of the department. To this end equipment is loaned contractors; whenever possible materials are furnished by the department, thereby reducing the capital invested by the contractor; estimates on work are promptly paid and our dealings all aim at an efficient dispatch of our business relations with commercial organizations. That our efforts have met with a measure of success is evidenced by the number of contractors who continue to seek work with the department. As a result of our five years' work we now have a following of reliable contracting organizations which can satisfactorily handle a large part of the construction, leaving to our own organization the more remote and hazardous projects and also the lighter repair, surfacing, and maintenance work. It is considered advantageous to retain a number of experienced men organized into construction units for special work and at the same time encourage commercial organizations to handle the larger portion of the construction program.

The bureau has developed an organization of efficient workers capable of directing the administrative and engineering work on a much larger program of construction than present appropriations would provide. As the road construction yet to be done in the National Forests is of such magnitude as to require many years' work, it is hoped that appropriations adequate for the purpose will be forthcoming before it is necessary to disband this splendid organization for the lack of funds to continue its operations.

Our organization has been changed somewhat in the matter of field offices, there now being district offices at Portland, San Francisco, Denver, Missoula, Ogden, and Albuquerque. The last three named offices were formerly suboffices. This change has proved advantageous, particularly as it permits the closer supervision of the work which is necessary with the increased activity in highway construction. The road work of the seventh forest district continues to be handled by the district engineer of this bureau in charge of post road work in the locality where the work occurs.

The year has witnessed the completion of a number of important projects. A section, 11 miles in length, of the Canyonville-Galesville Road in Oregon was completed at a cost of \$262,000. The Somes Bar section of the Klamath River project in California, 7.4 miles in length, was opened to traffic, giving better access to the Salmon River and Klamath River projects. On sections of this road excavation quantities exceeded 550 cubic yards per station for a graded width of only 12 feet. Exceptional progress has been made on other sections of the Klamath River, and it is hoped that at the end of the construction season of 1921 the entire Klamath River project, 49 miles in length, estimated to cost \$1,240,000, will be opened to traffic. Four and seven-tenths miles of the Cooks-Collins project in Washington have been completed at a cost of \$135,000. This road lies along the north bank of the Columbia River and is a part of the State highway system. The North Fork-Payette project in Idaho, another important highway, was completed at a cost of \$178,000 for 20 miles.

Among the more important projects under construction may be mentioned the Durango-Silverton and the Monarch Pass in Colorado, and the Ephraim-Orangeville in Utah, all of which cross mountain

ranges at an elevation of more than 10,000 feet. The Sevier-Cove Fort in south Utah and the Fourth of July Canyon in Idaho are important trunk-line roads which will be opened to traffic at the close of the present construction season. The Arroyo-Seco and the San Gabriel projects are of special interest to the people of southern California. Extremely heavy work is encountered on the San Gabriel, where the excavation for the 16-foot graded width averages 45,000 cubic yards to the mile.

To meet the wide range of conditions and varying traffic requirements it is necessary to allow considerable latitude in the standards of construction. Thus, for a forest protection road such as the Greer-Bungalow in Idaho the form of construction is simply graded earth 8 feet in width. This road will be primarily for the protection and administration of the forest area, although some development is expected to result from the improvement. In contrast with this is the Alberton project in Montana, which is part of a trunk highway and which is from 18 to 22 feet in width.

In the accompanying tabulations the activities of this bureau on forest road work have been summarized. All work which has been done under the 10 per cent fund, section 8 of the Federal-aid act, the Post Office appropriation, and with cooperative funds has been included in these tabulations.

Preliminary engineering investigations have been made on 4,588 miles of road. Surveys and plans have been completed or are in the process of preparation for about 2,200 miles of highways.

Construction is completed or in progress on 1,600 miles at an estimated cost of \$12,000,000. This is an average cost of \$7,500 per mile, which includes all engineering expenditures. In addition a number of cooperative projects have been built by the States. On these projects the surveys, plans and construction work are done by the States subject to the approval of the department.

*Engineering investigations and reconnaissance surveys.*

State.	Completed prior to June 30, 1919.			Completed fiscal year 1920.			Total completed to June 30, 1920.		
	Number of projects.	Mileage covered.	Estimated cost of construction.	Number of projects.	Mileage covered.	Estimated cost of construction.	Number of projects.	Mileage covered.	Estimated cost of construction.
Alaska.....	5	24	\$165,820				5	24	\$165,820
Arizona.....	12	251	1,488,723	3	47	\$321,127	15	298	1,809,850
California.....	32	886	4,875,219	4	104	983,030	36	990	5,858,249
Colorado.....	23	673	3,065,350				23	673	3,065,350
Florida.....	1	35	80,688	4	18	96,839	5	53	177,527
Georgia.....	2	25	141,447				2	25	141,447
Idaho.....	5	109	981,608	9	138	1,691,905	14	247	2,673,513
Maine.....				1	11	67,839	1	11	67,839
Minnesota.....				1	30	287,617	1	30	287,617
Montana.....	12	320	2,147,735	5	64	402,857	17	384	2,550,592
North Carolina.....	7	99	799,446				7	99	799,446
Nevada.....	4	102	314,600				4	102	314,600
New Mexico.....	7	136	314,083	1	14	87,496	8	150	401,576
Oregon.....	27	632	3,660,730	6	143	3,931,704	33	775	7,592,434
South Dakota.....	2	48	161,900				2	48	161,900
Tennessee.....	5	74	603,656				5	74	603,656
Utah.....	4	136	330,987				4	136	330,987
Virginia.....	5	99	593,122				5	99	593,122
Washington.....	19	266	3,857,398	3	22	504,730	22	288	4,362,128
Wyoming.....	4	82	283,100				4	82	283,100
Total.....	176	3,997	23,865,609	37	591	8,375,144	213	4,588	32,240,753

## Surveys and plans.

State.	Completed prior to June 30, 1919.			Completed fiscal year, 1920.			Total completed to June 30, 1920.			In progress June 30, 1920.		
	Number of projects.	Mileage covered.	Estimated cost of construction.	Number of projects.	Mileage covered.	Estimated cost of construction.	Number of projects.	Mileage covered.	Estimated cost of construction.	Number of projects.	Mileage covered.	Estimated cost of construction.
Alaska.....						\$677,269						
Arizona.....	8	226	1,371,546	9	65	570,433	9	65	\$677,269			
Arkansas.....	4	34	\$87,651	4	76	71,350	12	302	1,941,979			
California.....	1	3	495,176	1	10	2,031,111	2	44	159,001	44		\$159,001
Colorado.....	6	43	870,010	9	116	798,000	15	159	3,426,287	98		1,344,324
Florida.....	5	112	95,500	4	63	1,230	9	175	1,668,010	2		773,150
Georgia.....	1	29		1	1	124,480	2	30	96,730	41		
Idaho.....				1	9	240,967	1	9	124,480			
Minnesota.....	3	80	330,480	2	60	3,061	5	140	571,447	6		1,178,035
Montana.....				1	30	498,115	1	30	3,061			
North Carolina.....				4	44	173,523	4	44	498,115			
Nevada.....				2	17	133,768	2	17	173,523	2		245,000
New Mexico.....	2	38	123,563	2	27	270,096	4	65	257,331	1		269,273
Oregon.....	11	203	1,146,110	2	33	1,159,102	13	236	1,416,716			
South Carolina.....	14	139	2,349,580	8	69	60,378	22	208	3,508,682	3		380,924
South Dakota.....				1	5	360,650	1	5	60,378	3		980,920
Tennessee.....	1	17	85,800	3	52		4	69	446,450			
Texas.....	1	12	130,000				1	12	130,000			
Utah.....	5	193	680,362	1	21	74,067	6	214	754,429	2		261,863
Virginia.....				1	8	229,562	1	8	229,562			
Washington.....	6	25	447,196	4	41	965,015	10	66	1,412,211	25		612,571
Wyoming.....	3	150	668,059	2	54	344,000	5	204	1,012,059	2		411,000
Total.....	67	1,301	8,881,033	62	801	9,086,687	129	2,102	18,567,720	33		6,616,061



## Construction.

State.	Completed prior to June 30, 1919.			Completed fiscal year 1920.			Total completed to June 30, 1920.			In progress, June 30, 1920.		
	Num-ber of proj-ects.	Cost of construction.		Num-ber of proj-ects.	Mile-age cov-ered.	Cost of construction.		Num-ber of proj-ects.	Mile-age cov-ered.	Cost of construction.		Coopera-tive funds.
		Federal funds.	Coopera-tive funds.			Federal funds.	Coopera-tive funds.			Federal funds.	Coopera-tive funds.	
Alaska.....	.....	.....	.....	1	4	\$20,000	\$16,028	1	4	\$20,000	\$16,028	\$11,837
Arizona.....	.....	.....	.....	2	10	52,359	61,724	2	10	52,359	61,724	154,832
Arkansas.....	.....	.....	.....	1	34	.....	20,000	1	34	64,838	178,173	20,000
California.....	1	\$41,820	.....	4	12	214,434	40,800	5	27	236,254	40,800	241,533
Colorado.....	.....	.....	.....	3	34	132,591	37,869	3	34	132,591	37,869	372,065
Florida.....	.....	.....	.....	2	28	65,681	.....	2	28	65,681	.....	.....
Illinois.....	.....	.....	.....	2	23	112,754	92,377	2	23	112,754	92,377	.....
Minnesota.....	1	10,000	\$10,000	.....	.....	.....	.....	1	0.1	10,000	10,000	.....
Montana.....	1	32,000	32,000	3	28	99,115	105,756	4	32	131,115	137,756	.....
North Carolina.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nevada.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Mexico.....	.....	.....	.....	3	16	63,906	28,130	3	16	63,906	28,130	.....
Oregon.....	.....	.....	.....	4	22	165,102	254,653	5	25	172,533	255,774	37,392
South Dakota.....	1	7,431	1,721	.....	.....	.....	.....	.....	.....	.....	.....	634,083
Tennessee.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23,022
Utah.....	.....	.....	.....	1	29	60,678	24,587	1	29	60,678	24,587	60,000
Washington.....	.....	.....	.....	5	20	208,452	189,097	5	20	208,452	189,097	446,855
Wyoming.....	.....	.....	.....	1	11	33,059	.....	1	11	33,059	.....	415,359
Total.....	4	91,251	43,721	32	271	1,322,969	870,441	36	293.1	1,414,220	914,102	3,259,025

Total number of projects completed and under construction, 115, having a length of 1,563.1 miles and a total estimated cost of construction amounting to \$12,064,939.

*Cooperative project construction.*

State.	Completed prior to June 30, 1919.			Completed fiscal year year 1920.			Total completed to date.			In progress June 30, 1920.		
	Number of projects.	Mile- age cov- ered.	Total cost of con- struction.	Number of projects.	Mile- age cov- ered.	Total cost of con- struction.	Number of projects.	Mile- age cov- ered.	Total cost of con- struction.	Number of projects.	Mile- age cov- ered.	Esti- mated total cost of con- struction.
Arizona.....				1	9	\$183,000	1	9	\$183,000	1	42	\$295,787
Arkansas.....	1	15	\$38,822	1	20	46,016	2	35	84,838	2	35	87,651
California.....										3	37	366,000
Minnesota.....	1	1	20,998				1	1	20,998			
Montana.....	1	13	10,000				1	13	10,000			
New Mexico.....				1	2	7,183	1	2	7,183			
South Dakota.....										1	7	55,500
Utah.....	2	20	47,890				2	20	47,890			
Total.....	5	49	117,710	3	31	236,199	8	80	353,909	7	121	804,938

### DISTRIBUTION OF SURPLUS WAR MATERIALS, EQUIPMENT, AND SUPPLIES.

The amount of actual road construction during the past year has been greatly increased because of the road machinery and equipment transferred to the State highway departments from surplus war materials. This distribution commenced about June 1, 1919. Up to October 1, 1920, the total value of road-building equipment and supplies turned over to the State highway departments under the provisions of acts of Congress has been approximately \$100,000,000. The first act of Congress, approved February 28, 1919, was known as section 7 of the Post Office appropriation act. This act was supplemented by the Wadsworth-Kahn bill, approved March 15, 1920, known as Public 159, Sixty-sixth Congress. The latter act is more specific than the former, containing a specific list of road-building machinery and equipment that was to be available for transfer by the War Department to the State highway departments whenever any of it became surplus and not required for military purposes.

A representative of the Department of Agriculture was sent to France the first part of July, 1919, to assist the officials of the War Department in the selection of machinery and equipment suitable for road building to be returned to the United States in conformity with a cable from the Secretary of War, dated June 20, 1919, to the Liquidation Commission of the War Department in France.

There have been four allotments of motor vehicles, totaling 24,669. Of this number there were delivered on October 1, 1920, 92 per cent, or 22,719. A number of unserviceable motor vehicles have been accepted by the States with the understanding that they would not be counted in the total allotment to any State. They were desired for their parts for use in the reconstruction and maintenance of other motor vehicles received from the Army.

Shipments of road-building machinery and equipment are now being made in accordance with shipping instructions issued by this bureau, and it is expected that considerable additional material will be made available as soon as a final decision has been reached relative to the abandonment of some of the larger camps and cantonments by the Army.

The distribution of this material and equipment will be treated at a later date in a special report, which will include tables showing the amount of the several classes of material received and the amount allotted to each of the States.

#### ROAD MATERIAL TESTS AND RESEARCH.

During the past fiscal year the work of this division has proceeded vigorously, and although the routine testing has greatly increased in scope, particular emphasis has been placed on the development of the research work of the division. The vast expenditures of money for road construction, when taken into consideration with the rapid destruction of many road surfaces under heavy traffic, have rendered it necessary to institute a thorough investigation into the conditions which make for such rapid destruction and to discover, if possible, a means whereby designs of road surfaces may be provided to adequately take care of heavy traffic. The plan of research outlined in November of the preceding fiscal year working toward the more adequate design of roads was followed and increased in scope and a number of very enlightening facts have been developed during the year.

It was found, for example, in one series of tests with a loaded 5-ton truck traveling at 15 miles per hour and striking a surface depression only one-quarter of an inch in depth that the rear wheels delivered a blow to the road equivalent to four times the static load. Carrying the research a step farther it has been found that the intensity of the blow delivered is enormously reduced by the use of pneumatic instead of solid rubber tires.

The investigations which have for their purpose the improvement of methods of road surface design may be classified under the following main heads:

1. An investigation of subgrades and drainage.
2. Determination of the impact of motor trucks on road surfaces.
3. Investigation of the effect of impact on different types of road surfaces.
4. The relative wearing qualities of different types of road surfaces.

Three of these investigations were started during the previous fiscal year, and the investigation of subgrades during the early part of this fiscal year. Considerable headway has been made on all of them. Two papers appeared in *Public Roads* giving the results of the impact tests and one paper describing the general character of the entire investigation. One series of 49 road surfaces has been tested under the same kind of traffic and a paper on this subject will appear shortly. In addition, the impact tests for determining the relative load-carrying capacity of different surfaces are now about half completed and a paper will likewise be published on this investigation in a short time.

#### CONCRETE INVESTIGATIONS.

A series of tests was conducted to determine the crushing strength of concrete as affected by the addition of hydrate of lime and to determine the effect of mixing the concrete at a central mixing plant and hauling it before depositing at the work.



Preliminary experimental work was also performed on an investigation of blast furnace slag for use as a coarse aggregate in concrete.

A paper on "The pressure exerted by concrete against forms" was prepared and presented before the American Concrete Institute.

A paper was also published in our bureau magazine, *Public Roads*, on a new instrument designed and built in the division for measuring the wear of concrete roads under traffic.

An investigation of the effect on concrete of alkalies in the mixing water has been started.

#### NONBITUMINOUS ROAD MATERIAL INVESTIGATIONS.

An investigation of the chemical composition of blast furnace and smelter slags was made and samples tested from all of the principal slag banks in the country. Melts have also been prepared in the laboratory resembling blast-furnace slag.

An investigation of the variation in spelter coating on galvanized metal for the fabrication of corrugated metal culvert pipes was conducted, as well as a comparison of the lead acetate and antimony chloride-hydrochloric acid method for determining the amount of spelter coating. Several of the largest plants manufacturing sheet metal for galvanized metal culvert pipes were visited and data collected. A paper entitled "Galvanized culverts" was prepared and published in the May issue of *Public Roads*.

As a result of the quarry investigations undertaken during 1917 and 1918, the bureau was able to cooperate with the road materials committee of the American Society for Testing Materials in the preparation of tentative standards for sizes of crushed stone. A paper on the subject was presented also at the annual meeting of the Crushed Stone Association at Louisville, Ky.

A number of concrete roads in the State of West Virginia, in which soft sandstone was used as aggregate, were inspected for the purpose of noting results in service as compared with laboratory tests to which the material has been subjected.

The study of industrial practice in the preparation of commercial broken stone aggregates, continued from the previous year, was carried on in eastern Massachusetts, Connecticut, and Virginia. A statistical study was made on the nonbituminous road material supplies of 19 Southern and Middle Western States. Road material statistics were compiled through correspondence with a large number of sand, gravel, and broken stone producers in the United States. Information was likewise gotten with respect to Portland cement production as affecting road construction. Sand and gravel production investigations were made in Maryland, Virginia, Pennsylvania, New York, the New England States, and Wisconsin.

#### PHYSICAL TESTS OF ROAD-BUILDING MATERIAL.

During the year 1,026 samples of road-building materials were examined in the physical laboratory, as compared with 1,084 samples during the preceding year. The larger number tested during the preceding year is accounted for by the testing of a large number of concrete samples submitted from the District of Columbia. The number of samples tested during the past year is well above the aver-

age of routine work in the physical laboratory. The samples may be classified as follows:

Rock.....	319	Slag.....	55
Sand.....	244	Concrete.....	48
Gravel.....	203	Brick.....	6
Cement.....	88	Miscellaneous.....	63

Samples were received from 43 States and also from the Dominican Republic, West Indies. Below is given the geographical distribution of samples examined:

Alabama.....	28	Missouri.....	9
Arizona.....	11	Montana.....	30
Arkansas.....	48	Nebraska.....	11
California.....	3	New Hampshire.....	1
Colorado.....	12	New Jersey.....	15
Connecticut.....	2	New York.....	5
Delaware.....	10	North Carolina.....	31
District of Columbia.....	55	Ohio.....	126
Florida.....	37	Oklahoma.....	78
Georgia.....	11	Oregon.....	4
Idaho.....	2	Pennsylvania.....	44
Illinois.....	2	South Carolina.....	42
Indiana.....	12	South Dakota.....	3
Iowa.....	4	Tennessee.....	15
Kansas.....	14	Texas.....	3
Kentucky.....	8	Utah.....	12
Louisiana.....	21	Virginia.....	102
Maine.....	3	Washington.....	1
Maryland.....	49	West Virginia.....	17
Massachusetts.....	33	Wisconsin.....	35
New Mexico.....	2	Dominican Republic.....	9
Michigan.....	23		
Minnesota.....	8	Total.....	1,026
Mississippi.....	35		

#### MICROSCOPIC EXAMINATION AND CLASSIFICATION OF ROAD-BUILDING ROCK.

The petrographic laboratory examined 865 samples of road materials during the year, an increase of almost 27 per cent over the preceding year and well above the average of routine work. Of these samples 339 were rock, 53 slag, 205 gravel, 214 sand, 52 clay, and 2 miscellaneous.

#### RESEARCH ON DUST PREVENTIVES AND ROAD BINDERS.

The following investigations have been under way on bituminous materials:

1. Investigation of the process of refining crude petroleums.
2. Exposure tests on road oils and asphalts to study the effect of weathering and atmospheric exposure.
3. Investigation of the effect of so-called white and black alkalies from New Mexico on asphaltic cements.
4. Investigation relative to the new penetration needle.
5. Study of density and voids in bituminized aggregates.

In the investigation of the process of refining crude petroleums seven experimental steam distillations were made, using three typical crude petroleums. From the data collected in this manner and from the extensive testing of 187 samples from the experimental refinery a paper on "Some relations between the characteristics of steam-

distilled petroleum residuals" was prepared and presented at the last annual meeting of the American Society for Testing Materials.

The work done on the study of the asphalt content of road oils during the preceding year was worked up and presented in the form of a paper at the last meeting of the American Society for Testing Materials.

#### ROUTINE CHEMICAL TESTING AND INSPECTION.

Seven hundred and eighty-three samples were examined in the chemical laboratory. This represents an increase of 197 per cent as compared with the preceding fiscal year. Of the samples examined 365 were bituminous materials, 406 metal, and 12 miscellaneous. In addition, analyses of 40 samples of smelter slags and 29 samples of blast-furnace slags were made.

#### CONFERENCE OF STATE TESTING ENGINEERS AND CHEMISTS.

In February the second conference of State highway testing engineers and chemists was held at the bureau. Representatives of practically all the State highway department laboratories were in attendance. Standards for use in the making of tests for Federal-aid work were adopted by this conference and will be published by the bureau.

#### STANDARDIZATION OF METHODS OF TESTING NONBITUMINOUS ROAD MATERIALS.

Research work on proposed modifications of the standard abrasion test for rock was completed and a paper on this subject presented at the twenty-third annual meeting of the American Society for Testing Materials. The study of methods of testing the quality of granite paving block in the laboratory was completed and a paper on the subject prepared for publication in the technical press.

Methods of soil analysis adapted to a study of road subgrade materials were developed for use in connection with a systematic study of the bearing power of soils to be undertaken during the coming year.

Experiments in developing apparatus adapted to the rapid testing of road materials in the field were continued.

#### STANDARDIZATION OF METHODS OF TESTING BITUMINOUS ROAD MATERIALS.

Cooperation with the American Society for Testing Materials was continued through the committee on road materials. The following investigations will be of direct benefit in the standardization work of the bituminous section of committee D-4:

Methods of making penetration test.

Methods of making float test.

Standardization of viscosity test for road oils.

The work on "asphalt content" will also be of direct use in the standardization work of the committee.

#### FEDERAL-AID WORK.

Of the samples examined in the physical, chemical, and petrographic laboratories, 875 were materials for use in Federal-aid construction, as compared with 355 samples examined for similar use during the preceding year.

Test reports, numbering 24,985, submitted by laboratories throughout the country on samples of material used in Federal-aid road



construction were examined and comments prepared regarding them. In addition, 98 specifications proposed for use in Federal-aid construction were examined and recommendations were made regarding those parts of the specifications dealing with materials.

#### INSTRUMENT MAKING AND REPAIRING.

During the year the machine shop has completed 236 jobs, as follows: Division of tests, 146; engineering, 4; general office, 74; drainage, 12.

#### ROAD BUILDING AND MAINTENANCE INVESTIGATION.

Requests for the assignment of an engineer to assist in planning systems of highways were received from 11 localities; and the Arizona highway department requested the services of an engineer to check a number of tests of cement. All these requests were referred to the respective district engineers of the bureau for attention.

Reports on road systems were made for the Navajo Indian Reservation in Arizona, and for Caribou County, Idaho. A special report dealing with the design of a retaining wall was prepared for Wise County, Va.

Designs for bridges were prepared as follows: Alabama, 1; Kansas, 1; South Carolina, 1. The design prepared for South Carolina is for a reinforced concrete arch bridge having a single span of 170 feet and a total length of bridge of 424 feet, with a 20-foot roadway.

Engineers were assigned to investigate proposed bridge structures, as follows: Kentucky, 1; Virginia, 1.

The bureau also adapted plans for structures on the national forest roads to the use of a considerable quantity of bridge material which was declared surplus by the War Department and transferred to the Department of Agriculture.

In addition to the above, general designs were prepared and distributed on request, and plans prepared by State and other officials have been reviewed.

#### FIELD EXPERIMENTS.

Approximately 26 miles of experimental roads, which had been constructed during previous years in Alexandria and Fairfax Counties, Va., in Montgomery County, Md., and in the Department of Agriculture grounds, were maintained, and statistics relating to the cost of keeping them in repair were collected.

At the end of the year, on account of the reduction in the appropriation, it was necessary to relinquish the maintenance of the roads in Montgomery County and the Gum-Spring-Mount Vernon road in Fairfax County.

#### ROAD MANAGEMENT AND ECONOMICS.

In January of this year Col. Ralph Hess was appointed chief of economics in place of Mr. J. E. Pennybacker, who resigned during the preceding fiscal year. Before Col. Hess could assume his duties at the bureau he was recalled to temporary service with the army in Europe, and at the end of the year was still in Army service.

Upon his return to the bureau it is planned to enlarge and extend the work of the Economics Division, particularly with respect to the

study of labor and transportation conditions affecting highway construction.

#### MODELS AND EXHIBITS.

Practical demonstrations by means of models and other exhibit materials were made during the year to illustrate the various activities of the bureau. This exhibit material was built and maintained by the bureau, but all expenses of transportation and installation at the following fairs were paid by the office of exhibits from an appropriation made by Congress for exhibition purposes. All exhibit work was carried on under the general supervision of the office of exhibits of the department, which placed a combined department exhibit on display at the following fairs or expositions.

Name of fair.	Place.	Date.
Missouri State Fair	Sedalia, Mo.	Aug. 9-16, 1919.
Illinois Centennial State Fair	Springfield, Ill.	Aug. 13-23, 1919.
Iowa State Fair	Des Moines, Iowa	Aug. 22-29, 1919.
Illinois-Indiana Fair	Danville, Ill.	Aug. 24-30, 1919.
Ohio State Fair	Columbus, Ohio	Aug. 25-29, 1919.
Minnesota State Fair	Hamline, Minn.	Aug. 30-Sept. 6, 1919.
Nebraska State Fair	Lincoln, Nebr.	Aug. 31-Sept. 5, 1919.
Indiana State Fair	Indianapolis, Ind.	Sept. 1-6, 1919.
Montana State Fair	Helena, Mont.	Sept. 8-13, 1919.
Kansas Free Fair	Topeka, Kans.	Do.
New York State Fair	Syracuse, N. Y.	Do.
Wisconsin State Fair	Milwaukee, Wis.	Do.
Rochester Exposition	Rochester, N. Y.	Sept. 11-16, 1919.
Washington State Fair	Yakima, Wash.	Sept. 15-20, 1919.
Eastern State Agricultural Exposition	Springfield, Mass.	Do.
Memphis Tri-State Fair	Memphis, Tenn.	Sept. 20-27, 1919.
Oklahoma State Fair and Exposition	Oklahoma City, Okla.	Do.
Oregon State Fair	Salem, Oreg.	Sept. 22-27, 1919.
International Farm Congress	Kansas City, Mo.	Sept. 24-Oct. 4, 1919.
Oklahoma Free State Fair	Muskogee, Okla.	Sept. 29-Oct. 4, 1919.
Interstate Fair Association	Trenton, N. J.	Sept. 29-Oct. 3, 1919.
Mississippi-Alabama Fair	Meridian, Miss.	Sept. 29-Oct. 4, 1919.
Brockton Fair and Horse Show	Brockton, Mass.	Sept. 30-Oct. 3, 1919.
East Texas Fair	Tyler, Tex.	Sept. 30-Oct. 4, 1919.
Utah State Fair	Salt Lake City, Utah.	Oct. 6-11, 1919.
State Fair of Texas	Dallas, Tex.	Oct. 6-19, 1919.
Virginia State Fair	Richmond, Va.	Oct. 6-11, 1919.
Alabama State Fair	Birmingham, Ala.	Do.
Southeastern Fair Association	Atlanta, Ga.	Oct. 11-21, 1919.
Southside Virginia Industrial and Agricultural Exposition.	Petersburg, Va.	Oct. 14-18, 1919.
Evansville Centennial Exposition	Evansville, Ind.	Oct. 14-24, 1919.
South Georgia Fair	Albany, Ga.	Oct. 20-25, 1919.
North Carolina State Fair	Raleigh, N. C.	Do.
Northeast Texas Fair	Pittsburg, Tex.	Oct. 21-Nov. 1, 1919.
Georgia State Fair	Macon, Ga.	Oct. 22-25, 1919.
Louisiana State Fair	Shreveport, La.	Oct. 22-27, 1919.
State Agricultural and Mechanical Association	Columbia, S. C.	Oct. 27-31, 1919.
Texas Cotton Palace	Waco, Tex.	Oct. 25-Nov. 9, 1919.
Arizona State Fair	Phoenix, Ariz.	Nov. 3-8, 1919.
Georgia-Florida Fair	Valdosta, Ga.	Do.
Carolina Fair	Greenville, S. C.	Do.
Albemarle Agricultural Association	Elizabeth City, N. C.	Nov. 11-15, 1919.
Southern Exposition Fair Association	Augusta, Ga.	Nov. 11-22, 1919.
Florida State Fair	Jacksonville, Fla.	Nov. 15-30, 1919.
International Live Stock Show	Chicago, Ill.	Nov. 22-Dec. 6, 1919.
U. S. Good Roads Association	Hot Springs, Ark.	Apr. 12-17, 1920.
Sanitary and Efficiency Show	Pittsburgh, Pa.	June 12-19, 1920.

Exhibit material was also loaned to the following fairs and expositions, the applicant in each case defraying all expense incurred in shipment and installation and return of the material to the bureau:

South Dakota State Fair, Brookings, S. Dak., September 8-13, 1919.

Tri-County Fair, Andrews, S. C., October 15-17, 1919.

Colleton County Fair Association, Walterboro. S. C., November 4-8, 1919.

A goods roads display at Wilmington, Del., by the State highway department of Delaware, November 21-25, 1919.

The Dayton Automobile Exposition, Dayton, Ohio, January 12-17, 1920.

The Ohio Good Roads Association, Columbus, Ohio, January 19-24, 1920.

Evansville Chamber of Commerce, Evansville, Ind., March 22, 1920.

#### ADDRESSES, LECTURES, AND PAPERS.

The practice of rendering technical advice through the medium of conferences, lectures, and the presentation of papers at public gatherings was continued during the year. Representatives were assigned to attend only those meetings and conferences of official bodies which were of State or Nation-wide importance. Ninety-seven special authorizations were approved by the Secretary's office for the detail of representatives of the bureau to attend special meetings of technical societies and associations and other meetings having a direct or an indirect interest in or influence on highway improvements. Of these authorizations 57 carried authority to deliver stated addresses, the remainder to attend and participate in the gathering.

#### PHOTOGRAPHIC WORK.

There were developed in the photographic laboratory 3,488 negatives, 19,410 prints were made, 1,064 lantern slides, 527 bromide enlargements, and 2,187 photostat prints.

In addition to this work 788 lantern slides were colored for lecture work, 193 bromide enlargements were painted for exhibition purposes, and 34 maps were mounted on cloth.

For the use of various individuals and organizations, including employees of the office, 3,043 lantern slides, 15,268 prints, and 394 bromide enlargements were loaned. At the close of the year the photographic files contained 22,057 negatives, 82,932 prints, and 11,543 lantern slides, showing a substantial increase in all branches of photographic work over the work performed during the previous fiscal year.

#### PUBLICATIONS.

Twelve publications dealing with special phases of the work of the bureau were issued during the year—three by the division of irrigation investigations, four by the division of drainage investigations, three by the division of rural engineering investigations, one by the highways division, and the annual report of the bureau.

In addition to these special publications, the bureau continued the publication of the monthly magazine, *Public Roads*, dealing with matters of interest to highway engineers, especially in connection with Federal-aid work.

One of the handicaps from which the bureau suffers is the insufficiency of the funds allotted to it for publication. A great amount of valuable information is acquired each year which it is impossible to issue in the form of publications of the department because of the limitation of the printing funds. The demand for *Public Roads* has grown to the point where it has become necessary to refuse requests for it, because the funds limit the size of the issue to 4,500 monthly.



## FARM IRRIGATION INVESTIGATIONS.

A large part of the food supply of the more arid States of the West is derived from irrigated land. The high prices of soil products and the scarcity of water due to long-continued droughts have forced attention to the need of more water for irrigation, and this in turn has reawakened an interest in the storage of flood waters, the improvement of canal systems, and the removal of waste water from water-logged lands. The division of irrigation is endeavoring to respond to this general demand for more water, better systems, and a more economical use of water to the extent of its men and means.

Until recently the chief efforts of the people of rural communities in the far Western States have been exerted in providing water for raw lands. The expenditure of a large sum by the Department of the Interior in work of this nature during the past 18 years gave an impetus to this kind of reclamation and induced corporations and private interests generally to undertake similar development. Owing to the depletion of Government funds for this purpose, construction work on Government projects is falling off, but the lessening of governmental activity has been followed by a corresponding increase in the action taken by private interests, communities, and States. These private undertakings, however, have to do mainly with the overhauling and enlarging of existing systems. Many of these were built more than a quarter of a century ago and are dependent on the summer flow of streams for their supply. The area irrigated by them can not be increased unless part of the flood waters are stored, but to provide funds for the building of high masonry dams requires the combined financial backing of entire communities. This in turn necessitates a reorganization into irrigation districts, and not infrequently the merging of all the irrigation interests on a stream under one central control. For the past year the most beneficial results derived from the work of this division have been gained through assistance rendered to communities in making preliminary surveys and reports of existing systems and, when found feasible, in aiding the water users under these systems to amalgamate their interests, build storage reservoirs, and adapt their main canals and distributaries to the more efficient irrigation of a larger body of land. In four counties of Utah the reconstruction work which has been carried out under the guidance of this bureau will result eventually in the reclamation of about 100,000 acres of additional land besides furnishing an adequate and dependable supply to nearly as large an area now insufficiently served. These striking results are a forecast of the greater accomplishments which may be confidently expected if the larger projects now under way or contemplated are carried to completion.

Apart from the foregoing, the several lines of investigation for the conduct of which this division was created have been continued. The apportionment of the flow of streams and canals among thousands of users has always proved a difficult task, and until facilities are provided so that the amount of water to which each is entitled is accurately measured controversies and litigation are certain to arise. Numerous experiments have been conducted at the hydraulic laboratory at Fort Collins, Colo., for the purpose of determining the efficiency of water meters in common use and also of devising new types. Of

the latter the Venturi flume seems to possess the greatest promise of future success. Although scarcely beyond the experimental state, several thousand of these meters are likely to be installed next season. One irrigation company in Texas is contemplating the use of 2,000.

In all new enterprises, such as irrigation districts and cooperative companies, the amount of water available and the amount required to irrigate the crops to be grown are vital factors which need to be determined before bonds are issued or construction begun. The various conditions which influence decisions of this nature have been studied by members of this division for a score or more years and the knowledge and experience which they have acquired create a demand for their services and enable them to render valuable assistance at a stage of proceedings when sound advice is urgently needed to attain success. A bulletin on The Western Farmer's Water Right has been published.

Several million acres of what formerly constituted the finest irrigated lands of the West are to-day partially if not wholly valueless through the rise of ground water and alkali. In nine cases out of ten the individual farmer is powerless to remedy this condition. To be successful it is something which communities must undertake, but before the necessary funds can be raised the State legislature must provide the requisite authority in the form of proper drainage district laws. The members of this division are aiding in the preparation of such laws, and in the organization of drainage districts. They also make preliminary surveys and estimates of cost and frequently supervise the construction of drainage systems.

Owing to the reduction in the appropriation it has been necessary to limit much of the work to States which are cooperating with the bureau by furnishing a portion of the funds. Among the important studies carried on under cooperative agreements have been the preparation of sectional maps showing the irrigated areas of California, an investigation of the irrigation of deciduous orchards in California, observations on the South Platte River in Colorado to determine the number and extent of diversions and the amount of seepage and return waters, keeping records of the fluctuations of the water table in New Mexico as a guide in planning for the drainage of water-logged lands, and studies of the use of water in western Texas.

The more extended use of concrete pipe to convey and distribute water for irrigation purposes is being urged in order to lessen the waste of water occurring in earthen channels. Two years ago the concrete-pipe industry of the Pacific coast was not on a creditable basis. Much of the pipe made was inferior in quality and little had been done to standardize the output of the various factories. As a result of two years' investigation by members of this division better materials are being used, the mixture better proportioned, the strength and durability of the pipe greatly increased, better facilities provided for the making of the pipe, and better methods recommended for laying it. A bulletin on The Use of Concrete Pipe for Irrigation has been submitted for publication.

Progress has been made in assembling data for the preparation of a report on the flow of water in metal pipe, which is to form part of the series of publications on the flow of water in various types of conduits.



## FARM DRAINAGE INVESTIGATIONS.

The scarcity of labor and the high prices of farm products have turned the attention of farmers to the desirability of utilizing improvements that will increase the crop yield and decrease the labor required in cultivation. As a result there has been a renewed interest in drainage despite the high cost of such work.

During the fiscal year drainage work was continued as during the previous year, the activities being limited only by the funds available. It was found necessary to discontinue some of the more expensive investigational lines of work, among which were: The investigations relating to flow in large tile, run-off from small areas, and run-off investigations in southern Louisiana. The results of these investigations would have been of great value to the engineers and landowners interested in drainage. All survey work on the large projects has been discontinued and such work confined to small projects and to the individual farm where only one engineer would be required on each project.

The cooperative agreements with the States of Alabama, Arkansas, Georgia, North Carolina, and Tennessee were continued.

Surveys were made and drainage plans were prepared for 156 farms in 14 States where the owners either desired the installation of tile or the construction of terraces. On many other farms field examinations were made and advice given informally.

At the request of drainage district officials, plans for the reclamation of a number of large drainage districts were examined. By a careful review of these plans it was possible in one case to suggest a change in design that resulted in a saving of \$100,000 to the landowners. In another district the recommendation to the officials prevented the adoption of a plan that was not in accordance with good engineering practice.

The field work on the Red River of the North, a project which involves the improvement of large areas of land in the States of North Dakota, South Dakota, and Minnesota, was completed and a progress report outlining a plan for reclaiming the land in the vicinity of Lake Traverse was prepared and transmitted. The preparation of the final report on the project was continued, and it is expected that it will be completed in a few months. A complete drainage survey of a portion of the Grand River bottom in Daviess County, Mo., was made and a report was prepared outlining a method of preventing overflows due to ordinary rainfall intensities.

Twenty-six preliminary examinations were made of overflowing streams and swamp areas in various States and reports were submitted to the interested landowners.

The records of rainfall and run-off, which have been kept continuously since 1910 in the prairie section of Louisiana, were continued until January, 1920, when shortage of funds made it necessary to discontinue the office of the division at New Orleans. An attempt has been made to continue these records by correspondence, but the results are not satisfactory.

The studies on the subject of drainage assessments were completed and the manuscript for a bulletin upon the subject is nearly ready for the printer. Numerous requests are received for information in regard to the manufacture of clay tile. An investigation of the



manufacture of clay drain tile was made, and the manuscript for a bulletin on this subject was prepared. The scarcity and high cost of labor has made hand ditching very expensive, and in some instances it has been found advisable to use explosives in constructing ditches which formerly would have been dug by hand. An investigation of the use of dynamite in the construction of drainage ditches is now in progress. The manuscript for a bulletin containing the results of investigations of pumping plants in southern Louisiana was completed. This bulletin presents the data relative to pumping plants that have been collected during the past 10 years in southern Louisiana. Farmers' Bulletin No. 698, *Trenching Machinery for Tile Drain Construction*, was revised and issued as Farmers' Bulletin No. 1131. Department Bulletin No. 300, *Excavating Machinery Used in Land Drainage*, has also been revised and brought up to date. An investigation of vertical drainage was completed and a manuscript for a Farmers' Bulletin on the subject is in preparation.

Investigations of the problems relating to the control of erosion were continued as opportunity offered, and considerable material was collected for a Farmers' Bulletin on soil-saving dams and other devices for controlling gulying. Farmers' Bulletin No. 997, *Terracing Farm Lands*, was reprinted in revised form.

Studies of the subsidence of muck soils after drainage were continued in Louisiana and in Florida. The investigation of the optimum depth of drainage for muck soils was continued in Florida.

Investigations in regard to the effect of depth of drain and distance between drains in tile drainage were continued. The investigation at Tarboro, N. C., was completed and a report prepared. Similar studies on another type of soil were made in Pitt County, N. C., and valuable data secured.

An investigation to determine the rate of run-off from tile-drained areas and the hydraulic factors that govern flow in large tile drains was begun in southwestern Minnesota in the spring of 1920 and is now in progress. An agreement was entered into with the commissioner of drainage and waters of the State of Minnesota which provides for cooperative hydraulic investigations on drainage ditches in the northwestern part of the State. The objects of these studies are to determine the rates of run-off that should be provided for in that territory, and to ascertain the proper value for the coefficient of roughness ( $n$ ) in the Kutter formula. These investigations are now in progress.

Investigations were started and are now in progress in the southwestern part of Minnesota to determine the extent and concentration of the alkalies that have caused the failure of a number of concrete tile drains in that section. The question of whether or not it is safe to use concrete tile in that part of the State is an exceedingly important one, as drainage districts have been organized which propose to construct tile drains which will cost several million dollars. Concrete tile has been the tile most used, and it is desirable to determine definitely the conditions under which the tile now manufactured can be safely used, and if possible to devise methods of improving the quality of the tile so that it will be more resistant to the action of alkalies present in the soil. The results of the investigation during the year were presented in a progress report that has been issued in mimeographed form.

Under agreement with the Florida experiment station cooperative experiments were continued upon the station farm at Gainesville, Fla., for the purpose of determining the value of sewage irrigation for that type of soil. The experiments with sewage irrigation and with the use of automatic valves for distributing the sewage were continued at Vineland, N. J. Several plans for small irrigation plants on farms in humid sections have been prepared and advice has been given to a number of farmers who were operating irrigation plants or desired to install such plants.

During the year the personnel of the division changed greatly. Several senior drainage engineers with long experience in the work resigned to accept more attractive positions. This loss hampered the work materially and prevented taking up important investigations, as it was impossible to replace the engineers who had resigned with engineers of similar experience and training. It has also been impossible to secure junior drainage engineers, although it is desirable to have a number in training who can later be promoted as vacancies occur.

#### RURAL ENGINEERING INVESTIGATIONS.

As was the case during the previous fiscal year, the work of the rural engineering division in 1920 was handled largely through correspondence, and consisted in responding to requests for information and advice on individual problems in the field of rural engineering.

The plans for sweet-potato houses which had been prepared in previous years in cooperation with the Bureau of Markets were widely distributed throughout the sweet-potato growing sections. A number of storage houses have been built from these plans. Reports received from the owners indicate a very much smaller loss from potatoes stored than that which formerly occurred.

A design for a simple water system consisting of a cistern and pitcher pump which can be cheaply installed in any home was prepared for general distribution. Assistance was given to several farmers who desired advice relative to water supply, septic tanks, and in one instance a farm dam. The preparation of a bulletin on Sewage and Sewerage of the Farm Home was nearly completed. Plans for septic tanks for three large rural schools were prepared. Studies were made and advice given relative to sewage disposal, drainage, and water supply of the new plant-detention station of the Bureau of Plant Industry near Bell, Md. Plans were also prepared for the installation of wash and toilet rooms for laborers at the Arlington Experiment Farm.

For general distribution there were prepared designs for farm buildings, as follows: A sheep barn, dairy barn, two cattle barns, horse barn, implement shed, cattle feed trough, self-feeder for hogs, smokehouse, and a hollow-tile sweet-potato storage house. Modifications were made in sweet-potato storage-house plans previously prepared. In addition, a number of designs and drawings were prepared for other bureaus of the department.

Farmers' Bulletin No. 1132, Planning the Farmstead, was completed and submitted for publication. A number of farmstead layouts were prepared in response to requests for assistance.

A paper on the "Standardization of cow mangers and litter carriers" was delivered before the farm equipment section of the Na-



tional Implement and Vehicle Association and the American Society of Agricultural Engineers. The standards for cow mangers that had been developed by representatives of these organizations and engineers of the division in cooperation were later accepted as the official standards by both organizations.

The development of apparatus for dusting cotton plants for the boll weevil, which had previously been designed, was continued in cooperation with the Bureau of Entomology. The designs were perfected, public patents granted and efforts made to bring about the commercial production of machines. In cooperation with the Bureau of Entomology there was prepared Farmers' Bulletin No. 1098, *Dusting Machinery for Cotton Boll Weevil Control*.

The work of the Secretary's committee on farm-equipment control, which was turned over to the division in the spring of 1919, was continued. A few licenses were issued to applicants.

Little interest was shown by thrashers and farmers in the grain-conservation work, taken over by the division upon the termination of the Food Administration's war activities. But one request for assistance in conducting "thrasher schools" was received. It was complied with.

Papers on "Special features of tractor-drawn implements" and the "Care and operation of separators" were prepared and read before the Farmers' Congress at Harrisburg, Pa., and the Brotherhood of New York Thrashermen at Rochester, N. Y., respectively.

A member of the staff assisted in the program of a "tractor school and demonstration" at Spartanburg, N. C.

Light and Power in Farm Homes was prepared for the yearbook and later published as a separate. Data was obtained for a publication describing methods adopted and the results obtained by two farmers in the utilization of small streams in generating electricity for their farms. A study was made of the sources of electrical energy available to farmers and the methods of securing current. The material obtained will be included later in a publication on the subject.

A Farmers' Bulletin on One-Register Furnaces was sent to press, also a bulletin on Proper and Economical Farm Home Heating.

In response to requests there were issued during the year 7,794 sets of plans for farm buildings and their appurtenances. In answer to requests for assistance in the solution of agricultural engineering problems, numerous data, sketches, and short articles on many subjects were prepared.

The Information Series used in connection with replies to requests for assistance was amplified by notes relating to the use of cold-water paints, domestic refrigeration, firms manufacturing or selling farm electric-lighting plants, and a discussion of round versus rectangular barns.

At the end of the fiscal year the direction of the division of rural engineering was transferred from Mr. E. B. McCormick to Mr. S. H. McCrory, who has had charge of the drainage work of the bureau for a number of years. Mr. McCormick will take charge of the newly organized equipment division which has been formed to look after the large amount of road-building machinery, automobiles, motor trucks, and other equipment transferred to the bureau by the War Department.



### SEPARATIONS FROM THE SERVICE.

During the fiscal year there were 84 resignations of engineers of all grades, and 63 resignations among the clerical and subclerical forces. Practically all of these employees resigned to take positions at higher salaries outside the Government service. Five engineers of the senior grade resigned to take positions outside the Government service at increases in salary ranging from \$2,500 to \$5,000 per annum. Two senior highway engineers received increases of \$500 and \$1,200 annually on resignation. One engineer economist accepted an outside position at an advance of \$1,140 per year. One highway engineer was offered and accepted a position paying \$900 more than he received from the bureau; one highway draftsman received an increase of \$720 annually by accepting an outside offer; and an architectural draftsman of long service with the bureau resigned to accept an annual salary of \$4,000, almost double the salary he received from the bureau.

Prevost Hubbard resigned as chief of the division of road material tests and research to become chemist for the Asphalt Association. He has been succeeded by Mr. A. T. Goldbeck.

J. T. Bullen, district engineer, resigned to accept employment as a county engineer in Louisiana.

To fill the vacancies left by the resignations and to provide for necessary enlargement of the force, a total of 230 engineers of all grades and 127 clerical and subclerical employees were employed during the year.

### COOPERATION WITH RECLASSIFICATION COMMISSION.

At the request of the Joint Commission on Reclassification of Salaries the bureau detailed to the commission one senior highway engineer from October 21 to December 12, 1919; one economic geologist from November 4 to 28, 1919; and one engineer-economist from August 13, 1919, to March 12, 1920.

Data furnished to the Joint Reclassification Commission showed that there were 715 people employed in the bureau, of which 180 were located within the District of Columbia and 535 outside at the 13 district offices. Of the total number 312 were classified as holding engineering positions and 403 as clerical, legal, and miscellaneous.



## REPORT OF THE CHIEF OF THE BUREAU OF MARKETS.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF MARKETS,  
*Washington, D. C., October 9, 1920.*

SIR: I have the honor to transmit herewith a report of the work of the Bureau of Markets for the fiscal year ended June 30, 1920.

Respectfully,

GEORGE LIVINGSTON,  
*Chief of Bureau.*

HON. E. T. MEREDITH,  
*Secretary of Agriculture.*

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Deep interest in current questions involved in the marketing of our agricultural products is manifested in all sections of the country; the discussion of marketing problems occupies a great deal of time at public gatherings of farmers and other persons concerned, and a great deal of space in the press, especially in rural and trade papers, is devoted to presenting various aspects of the subject. Many people who appreciate the relation between adequate agricultural production and satisfactory marketing conditions are deeply concerned over the situation which will confront the farmer during the next few years of the reconstruction period and many feel an actual fear for our national prosperity should production be curtailed. Therefore, it is probable that the consideration of marketing problems will continue to occupy the foremost place in the thoughts of both producers and consumers. There is a deep-seated dissatisfaction in many quarters on account of the apparently faulty functioning of our marketing machine, and a great deal of criticism arises because many people seem to feel that nothing effective is being done to combat the high cost of living, discriminations, unfair practices, unjust profits, unnecessary middlemen, unfair prices, manipulation, speculation, hoarding, improper grading, inadequate facilities for transportation and storage, and other evils of the day. Many persons believe that these evils can be corrected only by the substitution of a complete new system for the old order of things and others wish to cure all marketing difficulties by legislation. It is believed, however, that the majority of careful investigators, while recognizing and deploring existing imperfections, fully realize the impossibility of successfully substituting immediately any new scheme for the present complicated system, which is the slow growth of centuries. One of the important fundamental problems confronting marketing agencies is the education of the public to a point where it will generally realize



that the present marketing system is a product of evolution; that improvements must be made gradually by changes in method and procedure and by eliminating specific recognized evils; that it is impossible to set up instantly a perfectly efficient and automatically operated new marketing machine; and that it is also impossible to cure all economic ills by legislation. The public must appreciate also that marketing is quite as much a problem for the attention and consideration of the consumer as for the producer.

Ever since its institution, the Bureau of Markets has realized that certain objects must be accomplished before any generally noticeable marketing improvements could be made. Standards for farm products and the containers in which they are packed must be established; prompt, accurate, and disinterested domestic and foreign market information must be made available to all parties concerned in the process of distribution; impartial inspection must be maintained; the problems inherent in the organization and operation of farmers' cooperative organizations must be solved; the business practices of the various marketing agencies must be improved; accurate and complete data concerning the cost of marketing must be available; and efficiency in handling, storing, and shipping farm products must be increased. In all these directions measurable progress has been made and in the following pages of this report will be found a fairly complete statement of the ground covered during the fiscal year just closed.

During the year especial attention was given to questions bearing on the effective distribution of the information collected by the bureau, the publication of *The Market Reporter*, studies regarding the cost of marketing, the compilation of statistics on marketing, the development of a service to deal with foreign marketing, and the standardization of additional commodities.

*Distribution of market information.*—The question of distributing in an effective way the information collected by the Bureau of Markets has for many years been a difficult one. The market news services have been developed to a point where they very effectively meet the requirements of the agencies concerned in marketing or distributing the commodities dealt with, but until recently it has not been practicable to summarize the information issued through these various services and make it available in comprehensive form. The publication of *The Market Reporter*, discussed below, was a move in this direction, but the problem has not yet been completely solved.

It is felt that the market information of the bureau should be put into the hands of the farmer in simple, convenient form with the least possible delay. He has no time or inclination during a large part of the year to read extended summaries or long detailed tables, much less to analyze, interpret, and combine them, or to consider them in conjunction with other significant information, and yet it is vital that he should have information of this kind and be in a position to act upon it. This problem is being attacked as energetically as possible, and consideration is now being given to the development of a special service for weekly farm papers through which market information in suitable form should be placed in the hands of four to six million subscribers.

Plans are being made to increase our collection of motion pictures, to add to our lantern-slide lectures and exhibits, and to work out

other means for effectively and graphically presenting the work in all parts of the country.

*The Market Reporter.*—The first issue of *The Market Reporter* appeared on January 3, 1920. Its publication was undertaken because it was desired to have a medium for the presentation in convenient form of marketing information of both general and special interest, and of current as well as permanent value for the use of producers, dealers, and consumers. The large number of favorable comments received from the readers of the publication is very encouraging, and although it is only a few months old, it has clearly demonstrated its usefulness and has come to occupy an important place as a source of market information that heretofore has been inaccessible, or not available in convenient form. For the time being, it is sent free to anyone who individually requests it and indicates a need for it. The information contained in *The Market Reporter* reaches a great many readers because its articles are copied or quoted widely by magazines, rural and trade papers, and by the daily press. As the bureau desires to make *The Market Reporter* of maximum practical value, an inquiry will be made to determine the use that is made of the information published in its columns and the occupation of its readers. Wherever this study may indicate the desirability of so doing, changes in form or in character of information published will be made.

*Studies of the cost of marketing.*—Information regarding the cost of marketing must be available to supplement data concerning the cost of production. Exact, dependable information should be at hand showing what proportion of the consumer's dollar is received by the producer and the various marketing agencies, and indicating the economic justification for the existence of each link in the chain of marketing.

The retail marketing of meat is now being studied and it is hoped that this work can be completed at an early date. A survey of the marketing of milk and potatoes which has recently been instituted will be prosecuted with all possible vigor, and efforts will be made to determine the cost of marketing certain products through farmers' cooperative marketing associations. Effective steps should be taken to obtain information which may make it possible for cooperative organizations to improve their operating methods and it is believed that a comparison of their marketing costs with the costs of individual firms or corporations selling the same product may throw much light on the relative efficiency of the two.

The use of uniform, suitable accounts by various types of marketing agencies would be of great assistance in obtaining dependable data regarding the cost of marketing and should be the means of effecting important economies. Every effort, therefore, will be made to promote the use of the accounting systems already published and to hurry to completion those which have been partially finished. Suitable forms of accounts will be suggested to the industries whose costs are studied.

*Compilation of market statistics.*—Realizing the desirability of having in available form up-to-date, accurate, and complete statistics concerning the marketing of agricultural products, steps were taken during the year to form a statistical section in the bureau. In the course of our work, especially in connection with the market



news services, we have collected and distributed in mimeographed form extensive data relating to marketing conditions, receipts, shipments, supplies, prices, etc. When issued, this information was of current value and has been largely used in studying market fluctuations over short periods. Many of the files, however, now cover a period of years and when these figures are tabulated, summarized, and analyzed by a competent statistician they should indicate significant trends and be of great assistance in the analysis of fundamental factors affecting marketing conditions. These data should be of especial value, because they will be compiled from a general rather than a special standpoint and will be nation-wide rather than local in scope. At present, consideration is being given to the issuance of a comprehensive annual summary of marketing information in statistical form.

*Foreign markets service.*—The importance of developing a foreign markets service to obtain and disseminate information relative to our foreign trade in agricultural products has been evident to this bureau for some time, and since 1916 investigations have been conducted concerning the marketing of American agricultural products in foreign countries, preparatory to establishing a service of adequate size and scope when sufficient funds should be made available by Congress for its support. World markets have a deep and far-reaching influence on domestic markets and prices, but, although approximately 50 per cent of our exports last year consisted of agricultural products, and although the prices of some of our largest staple crops, such as wheat, cotton, and wool, are made in foreign markets, so little attention has been given to conditions which our farm products encounter in foreign fields that we have been without fundamental information which is of vital importance to our prosperity.

Other governmental agencies are interested in certain phases of our foreign trade, but they have never attempted to cover agricultural commodities in any adequate, systematic, or comprehensive way, and the Bureau of Markets, so far as it has been able to proceed with the funds in hand, has been developing a pioneer project.

In the annual report for the last fiscal year mention was made of the fact that in June, 1919, representatives were sent to South America to study the markets for purebred live stock and to acquaint South American producers with the merits of the stock raised in this country. The United States produces some of the best purebred live stock in the world, in rapidly increasing numbers, and the desirability of finding an outlet for it is evident. Most of this live stock is raised under climatic conditions similar to those prevailing in the Argentine Republic, Uruguay, Paraguay, and southern Brazil, where 60 to 90 per cent of the total industries consists of live-stock work. Both Argentina and Uruguay have many high-grade herds, the great live-stock show at Palermo, Argentina, being considered one of the best in the world. Brazil, in the past, has not given so much attention to live stock improvement, but is now taking rapid steps in that direction. For all of these reasons this seemed a most promising field to survey and this conclusion was justified by the fact that the trip of our representatives brought out excellent prospects for the development of a profitable trade. As a result of the contacts they established it appears that business was transacted up to June 30, 1920, amounting to over \$400,000. The results of this



trip have been so promising that it has been deemed advisable to keep a representative in South America and arrangements are now under way for the establishment of a permanent office there.

Brief mention also was made, in the last annual report, of the fact that in May, 1919, an agricultural trade commissioner had been sent to the United Kingdom to study the markets for agricultural products and to make regular reports, by letter and cable, for the information of American producers and exporters. Reports of conditions affecting American trade have been rendered regularly, and much advance confidential information of importance has been received. As an illustration it may be stated that the first information regarding the shipment of 300,000 carcasses of Australian lambs to this country was received in a cablegram from our commissioner on February 28. This was widely published and had the effect of steadying the domestic market. A special investigation was made of fruit marketing which made it clearly evident that much can be done to reduce present losses in transportation and handling. Prompt information was forwarded regarding British food and trading regulations, and numerous important reports published in England, but not heretofore received by us, were sent to the bureau. This work has proved its value, and is a strong recommendation for the appointment of several experienced trade commissioners to be sent abroad to aid in developing foreign markets for our agricultural products.

Our experience has indicated also the desirability of building up a staff of experts in Washington to obtain, summarize, and make public information concerning world supply and demand for the principal commodities, including production and carry-over, trend of consumption, trend of trade, etc. With the development of large cooperative societies of producers this information should be of vital importance and in great demand within a relatively few years.

*Heater car devised.*—Enormous losses are caused annually because large quantities of fruits and vegetables are frozen in transit. Last winter shippers of apples in three States—Oregon, Washington, and Idaho—filed claims against railroads amounting to over \$3,000,000 to cover losses from freezing. To assist in reducing such losses, the Bureau of Markets has distributed as widely as possible information relative to the proper methods of loading and heating both refrigerator and ordinary box cars. Recently, as a result of investigations, we have practically completed the design for heating equipment for use in connection with the United States standard refrigerator car, the specifications for which were drawn up in this bureau. Experiments have shown that a refrigerator car, equipped with this heating system, will protect fruits and vegetables from freezing, even at a temperature of 40 degrees below zero. Service tests, to adapt this heating system to practical every-day conditions, will be carried on during the coming winter.

*Standardization of wool.*—Various statements issued in the past have emphasized the importance of standardization work, which is basic to improvement in marketing. In the other sections of this report mention may be found of the work which has been done in connection with the standardization of such commodities as rice and other grains, fruits and vegetables, hay and live stock. The wool standardization work being our most important recent undertaking in this line should be emphasized at this point.

For some time past it has been realized that the situation in the wool industry made it necessary that steps be taken to enable wool producers, distributors, and manufacturers to conduct their operations on a more satisfactory basis. The chaotic conditions which govern the marketing of wool have been caused by a number of factors. The bulk of American wool is produced in the Central and Western States, while the manufacturing industries are located almost wholly in the North Atlantic Seaboard States and no organized central markets exist. Handling and marketing in the field are conducted in a haphazard, inefficient, and wasteful way in most cases. No recognized, nation-wide grades and standards have existed up to the present time and, until this bureau entered the field about two years ago, no adequate and reliable information was available regarding commercial supplies, movements, prices, or conditions.

Reports have been issued for some time regarding consumption and stocks of wool, and according to statements received they have been found invaluable by all wool-marketing factors. The impossibility of giving an effective market news service on wool until standard grades had been adopted, however, focused the attention of our wool specialists on the preparation of tentative wool grades, and during the past winter types of such grades were prepared. These types were based on careful studies of more than two years' duration, in the course of which several thousand samples believed to represent generally accepted commercial grades were examined. Before these tentative grades were put into final form they were submitted for suggestions and criticisms to the leading wool authorities of the country, including the American Association of Wool Manufacturers. These grades are based on diameter of fiber only, although suggestions have been made regarding the length of staple for classes within the various grades which has been found to be most adaptable for the different systems of manufacture. The establishment of these tentative grades was announced as widely as possible. Approximately 100 sets were sent out before the close of the fiscal year in response to applications from practically every State in the Union and from every branch of the wool industry, and about 130 requests for sets remained to be filled.

*Cooperative organization.*—The cooperative movement in the United States has grown very rapidly in recent years. There are in this country today approximately 15,000 farmers' organizations, with a membership of approximately 2,000,000 persons. Almost all of these organizations will be found at local markets, but their extension to terminal and distributing centers in greater numbers appears to be only a matter of time. One of the most important and difficult problems which we have to solve is how to assist cooperative agencies to educate the business men of the country so that they will concede the right of the farmer to enter the marketing field. Many successful business men are engaged in a number of enterprises, few confining themselves to one field of endeavor, and there appears to be no valid reason why the farmer should be denied the same privilege which they enjoy.

The Bureau of Markets makes general investigations concerning the status and progress of cooperation in the United States and gives, through its experts, advice and assistance to specific groups of producers who request help in organizing and operating cooperative



associations. It does not engage in general propaganda calculated to induce the formation of such associations, but, when it is apparent that cooperative effort is needed to overcome abuse, remedy inefficiency, or supply a recognized need, it suggests to producers the advisability of considering the formation of a cooperative organization, shows them how such organizations are formed and conducted, and explains to them the principles that must be observed in order to be successful.

*Reduction in funds.*—During the fiscal year 1920 the total appropriations available to the Bureau of Markets were \$2,911,365, the sum carried in the appropriation bill being supplemented by an allotment of \$100,000 from the funds of the wheat price guaranty Act for enforcing the amendments to the cotton futures Act provided for thereunder. The funds available during the previous fiscal year, 1919 (exclusive of the appropriation of \$10,000,000 for the purchase of nitrate of soda) were \$4,312,863, of which \$2,023,255 was carried in the appropriation act for the Department of Agriculture, \$2,004,608 in the food production Act, and \$285,000 (allotted for the stockyards supervision work) in the President's special fund for national security and defense. On account of the discontinuance of war funds, the bureau began the fiscal year 1920 with a reduction in available appropriations of \$1,401,498, and the necessary readjustments were made both in the lines of work and in assignment of the personnel.

A large number of resignations among our most competent workers, many of whom left the service to accept flattering commercial offers took place during the year. The fact that the established work has been well maintained and that the very satisfactory progress evidenced by this report was possible is a distinct indication of the ability, loyalty, and tireless industry of those who remained with the bureau during this trying period.

*Divisional organization.*—During the fiscal year the various projects of the bureau were grouped into a number of divisions, and the work of each will be discussed in the following pages.

### DIVISION OF LIVE STOCK, MEATS, AND WOOL.

The work of the Division of Live Stock, Meats, and Wool was supervised by Mr. Louis D. Hall until his resignation early in the calendar year. Mr. Hall was succeeded by Mr. Stephen Bray, who as division leader supervised the following work:

Investigations concerning the marketing of live stock, meats, and wool.

Market news service on live stock and meats.

Supervision of stockyards.

### MARKETING LIVE STOCK, MEATS, AND WOOL.

Investigations concerning the marketing of live stock, meats, and wool were conducted under the supervision of Messrs. Turner R. H. Wright, C. V. Whalin, and George T. Willingmyre.

The preparation of data regarding comparative costs and yields of the various wholesale cuts of beef has been undertaken and continued study has been made of the problems involved in marketing country hides and skins. Reports received from tanners and dealers



indicate that our efforts to bring about improvements have been effective.

In addition to the preparation and distribution of the tentative wool grades described in the first part of this report, eight expert wool classifiers were engaged in the spring to conduct wool grading demonstrations in Maine, New Hampshire, Virginia, Kentucky, Arkansas, and Missouri, from which States urgent requests for assistance had been received. These classifiers graded wool which had been centralized by wool growers' associations, farm bureaus and agricultural colleges as a demonstration and in order to test the practicality of the tentative wool grades. Demonstrations have also been conducted in 16 States to suggest the most practicable, efficient and profitable methods of preparing, storing, handling, grading, and marketing wool and the value of giving due consideration to market conditions at time of sale.

The survey to determine the location of purebred herds of the various breeds of live stock in this country, begun during the previous fiscal year for the convenience of purchasers, both domestic and foreign, has been continued.

#### MARKET NEWS SERVICE ON LIVE STOCK AND MEATS.

The division leader was assisted by Messrs. E. W. Baker, C. A. Burmeister, and W. C. Davis in the conduct of the Market News Service on Live Stock and Meats. The discontinuance of emergency funds caused a very heavy reduction in the funds available for this work, it being necessary to eliminate the service at 9 markets and reduce the force by approximately 155 persons. Although this reduction was made with the least possible disruption of work, it obviously narrowed the scope and made it much more difficult to furnish as efficient service as previously. Under emergency funds the bureau was able to operate 17,000 miles of leased wires, which were available for the collection and interchange of market information on such important commodities as live stock and meats, dairy and poultry products, and fruits and vegetables. It has been necessary to cut this mileage to approximately 5,000 miles, which makes it impossible to serve adequately such great agricultural sections of the country as the South, the Southwest, and the Pacific coast.

One of the chief problems considered was that of reducing the length of the reports without greatly affecting the value of the information contained therein. Definite improvement was made in this direction. Weekly reviews of the live stock market are now published at all offices and have been well received by producers and shippers who do not care to follow the market from day to day, many of those formerly receiving the daily reports having requested the weekly reviews instead.

The institution of The Market Reporter made it possible to publish certain monthly and weekly reports in permanent printed form, and this has resulted in reducing the cost of the reports. The Market Reporter has also provided a medium for the issuance of weekly, monthly, and semiannual reviews of the live stock and meat trade which could not be released before. These reviews are an attractive feature of the market news service on live stock and meats and have been commended by producers and members of the trade.

One of the most important achievements of the year was an arrangement made with various press associations and news agencies, by which they agreed to handle exclusively the live stock market reports furnished by the bureau representatives at East St. Louis, Kansas City, and Omaha. These reports replaced those obtained from unofficial sources, and placed these markets on the same footing with the Chicago market in this respect. An improvement also was made in the style of the reports, and after the new form was adopted the officials of the press associations and news agencies agreed not to make changes in the copy furnished them.

Constant effort was made to eliminate from the mailing lists all "dead" addresses. The lists at the branch offices are circularized every six to eight months, which prevents the accumulation of names of persons who do not use the reports and eliminates an important source of waste.

For some time it has been obvious that some effective steps must be taken to train the various persons reporting market prices and conditions in the various markets so that they will have, for practical purposes, the same conceptions as to what constitutes the various grades and classes of live stock and dressed meats. Only by attaining uniformity in this respect is it possible to make intelligible comparisons and issue comparable reports. This question presents many perplexing angles, and while satisfactory progress has been made in working out the details, much further work remains to be done. In order that the public may better understand the grading system in use, exhibits have been prepared consisting of transparent photographs in natural colors of typical specimens of each grade of live stock and the corresponding grades of carcasses and cuts of dressed meats. These photographs were obtained at the market centers by expert photographers and have been colored by expert colorists.

The monthly reports of raw stocks of hides and skins, begun during the previous year at the request of the Tanners' Council and various members of the trade, were continued and improved. At the close of the year this work was transferred to the Bureau of the Census.

#### FEDERAL SUPERVISION OF LIVE-STOCK MARKETS.

For the fiscal year 1920, \$75,000 was appropriated by Congress "to enable the Secretary of Agriculture to carry into effect until their termination the provisions of the proclamations of the President of June 18 and September 6, 1918, and the regulations thereunder relating to the stock-yards industry." Previously the work had been financed by an allotment of \$285,000 from the fund made available to the President for emergency expenditures. This appropriation of \$75,000 was intended to provide the means for carrying on the work for a few months, until legislation pending in Congress providing for the permanent regulation of this industry could be passed. Owing to the fact that it was possible to carry on this supervision work largely with the force engaged on the live stock and meat reporting service, it was continued throughout the fiscal year in spite of the inadequate appropriation. On June 30, the fund appropriated for the conduct of this work was exhausted, and it was necessary to



limit the supervision, although it had had an obviously good effect on the industry.

At the beginning of the fiscal year the curtailed appropriations made it necessary to close eleven field offices and later in the year work was discontinued at four other places. During most of the year, however, supervisors were maintained at Boston, Philadelphia, New York, Chicago, Omaha, Kansas City, National Stock Yards (Illinois), and St. Paul.

Three hundred and thirty-two licenses were issued to traders, order buyers, commission men, and others during the year, and five licenses were canceled for various reasons.

In the report for the last fiscal year mention was made of the discovery and proof that certain firms had been guilty of overcharging shippers for feed. In order to safeguard the public interest several licensees were notified that it appeared that they had been guilty of this practice and were given an opportunity to refund the overcharges. Six of the licensees so notified, however, sought and obtained from the district court at Chicago an order restraining the Secretary of Agriculture and his subordinates from revoking their licenses. These cases are still pending, and further action on all other cases involving overcharges for feed has necessarily been deferred awaiting their final decision.

From time to time adjustments have been made at various markets through which objectionable practices and irregularities have been eliminated. One such adjustment resulted in the settlement of a dispute between a stock yard company and live stock traders which had resulted in serious congestion in the yards and in consequent loss to shippers. In another case, where all dead stock arriving with shipments automatically became the property of the city in which the yard was located, an arrangement was effected whereby it was agreed that the shipper of such stock should receive for it prevailing dead-stock prices. These two instances are mentioned for purposes of illustration only. The great benefit resulting from this work is obvious, but much of it can never be measured, because the mere existence of the supervisory machinery prevented innumerable irregularities and inefficient and dishonest practices.

#### DIVISION OF DAIRY AND POULTRY PRODUCTS.

The work of the Division of Dairy and Poultry Products included the following activities and was directed by Mr. R. C. Potts:

Investigations concerning the marketing of dairy products.

Market news service on dairy and poultry products.

Butter inspection service.

#### MARKETING DAIRY PRODUCTS.

During the fiscal year the attention of the workers on the marketing of dairy products was directed principally to developing and perfecting the monthly fluid milk market report, to compiling statistics regarding the dairy industry, and to investigating the problems involved in the business management of milk distributing plants. Through questionnaires and personal visits, definite and complete information regarding market conditions and the basis of



prices existing in the markets was obtained and with supplemental explanations the report on milk prices was considerably improved. This report, of which over 7,000 copies are issued monthly, covers over 100 of the more important milk-distributing markets in the United States.

Investigations of the problems involved in the business management of milk plants were made at Cumberland, Md., South Bend and Indianapolis, Ind., Grand Rapids and Benton Harbor, Mich., Sedalia, Mo., and other cities, where particular attention was given to various phases of the managerial problems in cooperative or farmer-owned plants.

Reports showing the total monthly production of various kinds of manufactured dairy products were issued quarterly. A report was prepared in mimeographed form giving the production of such commodities by States in 1919, with comparative figures for 1918.

The division leader was assisted in conducting this work by Messrs. G. P. Warber and Warren H. Barber.

#### MARKET NEWS SERVICE ON DAIRY AND POULTRY PRODUCTS.

An appropriation to provide for the market news service on dairy and poultry products, which was directed by Mr. L. M. Davis, was included in the agricultural act for the fiscal year 1920, funds during previous years having been included in the food production Act. Branch offices were operated at Boston, Chicago, Fond du Lac, Minneapolis, New York, Philadelphia, and San Francisco, the office at Portland, Oreg., having been closed on October 1, 1919. Daily and weekly butter market reports, daily and weekly cheese market reports, daily egg and dressed poultry market reports and monthly export, cold storage, and condensed milk reports were issued to a total mailing list of nearly 10,000 persons and firms from whom specific requests for the reports were received. Many requests were received for additional information concerning eggs and live and dressed poultry, which information the bureau was unable to furnish because of inadequate funds for the development and conduct of this phase of the work.

#### BUTTER INSPECTION.

The butter-inspection service was conducted at Boston, Chicago, New York, and Philadelphia. This work was received with increasing favor during the year, a total of 2,421 inspections having been made, for which fees amounting to \$4,582.64 were collected and covered into the Treasury as miscellaneous receipts. All butter purchased in the open market by the Navy Department in Boston, New York, and Philadelphia is contracted for subject to Bureau of Markets inspection, as is also butter purchased by certain State, municipal, and private institutions. This service was supervised by Mr. C. W. Fryhofer.

#### DIVISION OF FRUITS AND VEGETABLES.

In the fall of 1919 the following projects were placed in the Fruit and Vegetable Division of the bureau, under the general supervision of Mr. Wells A. Sherman:

Market news service on fruits and vegetables.

Market news service on peanuts.  
 Market inspection of fruits and vegetables.  
 Enforcement of the standard-container Act.  
 Market grades and standards for fruits and vegetables.  
 Market surveys, methods, and costs.

#### MARKET NEWS SERVICE ON FRUITS AND VEGETABLES.

The telegraphic market news service on fruits and vegetables during the calendar year of 1919 included 36 commodities, on most of which complete daily reports were issued in season covering car-lot shipments, arrivals, and jobbing prices in the principal markets throughout the country, as well as f. o. b. prices and other shipping-point information on the more important crops. Mr. C. W. Kitchen directed this work.

Reports were obtained on the following commodities:

Apples.	Grapes.	Pears.
Asparagus.	Green peas.	Peanuts.
Bunched vegetables.	Honey (semimonthly).	Plums.
Cabbage.	Honey-dew melons.	Prunes.
Cantaloupes.	Lemons.	Spinach.
Casaba melons.	Lettuce.	Strawberries.
Cauliflower.	Mixed citrus fruit.	String beans.
Celery.	Mixed deciduous fruit.	Sweet potatoes.
Cherries.	Mixed vegetables.	Tangerines.
Cucumbers.	Onions.	Tomatoes.
Dry beans.	Oranges.	Watermelons.
Grapefruit.	Peaches.	White potatoes.

Early in the past fiscal year 18 market stations were operated at the points listed below. Because of curtailed appropriations, however, it was necessary to discontinue four of these stations before June 30, 1920.

Baltimore.	Denver. <sup>1</sup>	Omaha.
Boston.	Detroit.	Philadelphia.
Buffalo. <sup>1</sup>	Kansas City.	Pittsburgh.
Chicago.	Los Angeles.	Portland. <sup>1</sup>
Cincinnati.	Minneapolis.	St. Louis.
Cleveland.	New York.	San Francisco. <sup>1</sup>

Temporary field stations were operated during the calendar year at 54 points in the various producing sections during the important car-lot movement. This is a decrease of about 20 per cent compared with the number of field stations operated in the year 1918.

At the beginning of the fiscal year the branch offices in the large cities listed were connected by leased-wire circuits having their focal point in Washington, but decreased appropriations made it necessary to eliminate the wires to Denver, Los Angeles, San Francisco, Portland, and Minneapolis. These changes decreased the leased-wire mileage used in connection with the market-news service on fruits and vegetables from 9,000 to approximately 5,000 miles. Leased-wire service also was given the following temporary stations during the period of their operation:

Rochester, N. Y.	Grand Rapids, Mich.	Brawley, Calif.
Orlando, Fla.	Waupaca, Wis.	Turlock, Calif.
Princeton, Ind.	Greeley, Colo.	Idaho Falls, Idaho.

<sup>1</sup> Discontinued.

Wire communication with the other 45 field stations in producing districts was made by means of commercial telegrams, either directly from Washington or by relay from the nearest permanent branch office.

Owing to decreased funds, the year 1919 witnessed a considerable decrease in the number of mimeographed daily market reports. The offices in terminal markets distributed approximately 13,500,000 regular and special reports, while the field stations issued approximately 3,000,000, making a grand total from all stations of approximately 16,500,000, as compared with 23,000,000 during the preceding year. The mailing lists contained approximately 90,000 names, a decrease of almost one-third from the previous year.

In certain of the cities where branch offices were located local market reports were issued, giving daily receipts of practically all commodities and the prices at which such goods were retailed. Local newspapers cooperated rather extensively by publishing on their financial and market pages portions of these reports.

The Weekly Crop and Market Review of Fruits and Vegetables was enlarged during the year to include crop news, estimates of production, etc., such items being secured by means of a corps of 200 voluntary reporters in important producing sections. This work was approved by the Bureau of Crop Estimates, which had no funds available for its conduct.

A short week-end review was prepared for the benefit of papers that are unable to use the more extensive weekly review and was sent to about 60 papers having approximately half a million subscribers. A monthly news story was sent to about 50 periodicals and press associations.

The Weekly Summary of Car-Lot Shipments was continued during the year, and semimonthly reports on honey and beeswax have been sent to about 3,000 honey producers and others interested in this industry. Various special articles on the principal fruits and vegetables were issued through The Market Reporter; information concerning the marketing of fruits and vegetables was sent daily and weekly by telegraph to farm bureaus and periodicals; and articles were distributed on Friday afternoons to various press agencies for the use of newspapers that do not publish the more technical market reviews.

Through a cooperative arrangement with the officials of the State of Pennsylvania, a loop of the leased-wire system has been installed at Harrisburg. This makes possible an intensive distribution of market news in that State.

#### MARKET NEWS SERVICE ON PEANUTS.

The growth of the peanut industry in this country and the attendant marketing problems caused Congress to establish a market news service on peanuts during the last fiscal year. An appropriation of \$12,000 was made available for this work; and since for certain phases of this service the machinery established in connection with the market news service on fruits and vegetables could be utilized, it was possible to conduct it with the sum appropriated. Mr. C. W. Kitchen has assisted the division leader in this work.



Peanuts pass through a manufacturing process before reaching the consumer and do not travel through the same channels of distribution as fruits and vegetables. These considerations brought up new problems to be solved before this service could be put on a practical basis. Investigations of marketing methods and conditions were made in the important producing States of Texas, Alabama, Florida, Georgia, North Carolina, and Virginia. Early in November, 1919, a representative of the bureau was stationed at Suffolk, Va., who wired to Washington regularly the prices which were paid the growers for farmer's grade peanuts and the prices received f. o. b. shipping point for the manufactured product. Contacts were established with reliable representatives of the industry in important centers of the Southeast and Southwest to furnish similar data by telegraph. Arrangements were made with the agents of the different railroads and boat lines serving the important Virginia-North Carolina section to report weekly by mail the shipments in pounds of shelled and unshelled peanuts. Representatives of the market news service on fruits and vegetables in Boston, New York, Philadelphia, Pittsburgh, Chicago, and St. Louis reported the car-lot arrivals and wholesale prices of peanuts in those markets. Until the discontinuance of the offices at Portland and San Francisco reports of f. o. b. market conditions on Asiatic importations at those ports also were received. The food products inspector at San Francisco continues to report the quantities of oriental peanuts and peanut oil received at that port, and through a cooperative arrangement with the Bureau of Chemistry at Seattle a record of importations for the Seattle customs district is obtained.

Every effort is made to obtain all possible information concerning the peanut situation in the Orient, because this factor vitally influences the domestic market. During the year more than 132,000,000 pounds of peanuts, besides a large quantity of peanut oil, were imported, largely from China and Japan. This amount is nearly double that imported in any previous year and has caused considerable apprehension and uncertainty as to the future of the peanut industry in this country. At the request of this Bureau, the State Department sent to the important peanut-growing consular districts in China, Japan, India, and Africa, instructions for a detailed review of the industry in those districts. Information obtained from this source has been distributed to peanut growers and the trade.

Approximately 70,000 reports on peanuts were issued during the fiscal year 1920, semiweekly, to a mailing list consisting of about 1,300 names.

#### MARKET INSPECTION OF FRUITS AND VEGETABLES.

Mr. C. T. More directed the market inspection of fruits and vegetables until his resignation in the fall of 1919, when this project was placed in the fruit and vegetable division. In this division, Mr. H. E. Kramer supervised the work until his assignment to other duties, when he was succeeded by Mr. F. G. Robb.

At the beginning of the fiscal year 1920, the Food Products Inspection Service was operating through 29 central offices, which number was reduced to 23 by June 30, 1920, as shown in the table below. In addition to these central offices at which inspectors were

stationed, service was rendered at 150 other markets in the adjacent territory.

Atlanta, Ga.	Detroit, Mich.	New Orleans, La.
Baltimore, Md.	Fort Worth, Tex.	New York, N. Y.
Boston, Mass.	Houston, Tex.	Omaha, Nebr.
Buffalo, N. Y.	Indianapolis, Ind.	Philadelphia, Pa.
Chicago, Ill.	Jacksonville, Fla. <sup>1</sup>	Pittsburgh, Pa.
Cincinnati, Ohio.	Kansas City, Mo.	Portland, Oreg. <sup>1</sup>
Cleveland, Ohio.	Los Angeles, Calif.	St. Louis, Mo.
Columbus, Ohio. <sup>1</sup>	Memphis, Tenn.	San Francisco, Calif. <sup>1</sup>
Denver, Colo. <sup>1</sup>	Milwaukee, Wis.	Washington, D. C.
Des Moines, Iowa. <sup>1</sup>	Minneapolis, Minn.	

The total number of inspections throughout the year approximated 25,500, which is an increase of 75 per cent over the record for the fiscal year 1919. These inspections covered 40 different vegetables, 25 fruits and several kinds of nuts. Owing to insufficient force it has been necessary to decline 3,150 applications. About 25 per cent of the requests for inspection were received from carriers, 25 per cent direct from shippers and 50 per cent from receivers. The total fees received for fruit and vegetable inspections during the fiscal year amounted to approximately \$57,000, this sum being covered into the Treasury as miscellaneous receipts.

Inspections have been made on behalf of the United States Navy throughout the year at New York City. Just before the close of the fiscal year similar work was instituted at the Great Lakes Naval Training Station. Such economies have been effected that the Navy Department has requested that fruit and vegetable inspectors be assigned to its work at Boston, Philadelphia, Norfolk, Hampton Roads, San Francisco, and San Diego.

Cooperative work is done in California in working out the details of a shipping point inspection service, to be conducted by the State Department of Agriculture.

#### ENFORCEMENT OF THE U. S. STANDARD CONTAINER ACT.

The work of enforcing the provisions of the United States standard container Act during the year has been devoted largely to enlisting the cooperation of manufacturers of the containers to which the act relates, that is, Climax or grape baskets and tills or small fruit baskets, so that nonstandard forms would be eliminated. Tests showed that about 38 per cent of the containers tested did not conform to the established standards, and in all such instances the necessary changes were willingly made by the manufacturers. This project was supervised by Mr. F. P. Downing until he resigned in April, 1920, when he was succeeded by Mr. H. W. Samson.

#### MARKET GRADES AND STANDARDS FOR FRUITS AND VEGETABLES.

After the resignation of Mr. C. T. More, Messrs. H. E. Truax and H. W. Samson directed the work of market grades and standards for fruits and vegetables. Later Mr. Truax was assigned to cooperative work in the State of California, since which time Mr. Samson has acted as project leader.

As a result of the investigations concerning the grading of barreled apples, the tentative grades which had been prepared previ-

<sup>1</sup> Offices closed during fiscal year 1920.

ously have been somewhat modified, and are now considered ready for general adoption. Work on the grading of boxed apples has progressed in the Western States, and as a result uniform grades have been adopted by the States of Washington and Idaho. Operators in Oregon also have signified their intention of using these grades.

Investigations of the grading of sweet potatoes were made in the South; studies of asparagus grading in South Carolina, New Jersey, and Illinois; and investigations concerning peach grading in the States of Georgia, Virginia, West Virginia, Maryland, Delaware, New Jersey, Oklahoma, Texas, and New York. Tentative grades for peaches are in course of preparation, and the information gathered in connection with this work has been used by the New Jersey State Horticultural Society in developing grades for the use of peach growers in that State. Investigations regarding the grading of cabbage and tomatoes were conducted in both southern and northern producing districts, and tentative grades for both of these vegetables have been prepared.

Investigations dealing with the preparation of peaches for market have been resumed, and further experiments have been made with the peach grading and sizing machine which was developed by this bureau.

Studies of the capacity, dimensions, shape, type, and strength of various containers for fruits and vegetables have been made, and the preparation of legislation dealing with the standardization of containers has been considered in cooperation with officials of various States and of the District of Columbia.

Cooperative arrangements have been made with the department of agriculture of the State of California for the employment of a specialist, who is conducting investigations relating to the establishment of definite grades and standards for California products and containers.

#### MARKET SURVEYS, METHODS, AND COSTS.

Daily reports have been secured regarding the amounts of the following commodities unloaded in 14 markets: Apples, cabbage, cantaloupes, celery, onions, peaches, strawberries, tomatoes, and white potatoes. These reports concern both car-lot and less-than-car-lot shipments and are secured each day from all railroads, boat lines, and the express company in the respective market centers. During the year these data have been collected in Boston, Chicago, Cincinnati, Cleveland, Detroit, Kansas City, Minneapolis, New York, Omaha, Philadelphia, Pittsburgh, St. Louis, St. Paul, and Washington. Consideration has been given to assembling, editing, and analyzing these statistics, and a series of articles based upon them has been published in *The Market Reporter*.

The collection of reports of shipments of fruits and vegetables was continued throughout the year, but local freight agents now submit a monthly report of the daily shipments from each station instead of a daily post-card report as heretofore. Reports were received throughout the year from a total of 10,375 agency stations, including steam and electric roads, boat lines, and the express company. More than 600,000 carloads of approximately 50 commodities were reported in



this manner during the year. These reports differ from the telegraphic reports rendered by division superintendents, in that they localize by exact billing stations the source of the shipments of various fruits and vegetables and cover nearly twice as many commodities as are covered in the telegraphic news service. The data thus obtained constitute a valuable supplement to those included in the telegraphic service.

#### DIVISION OF COTTON MARKETING.

In accordance with the grouping of the projects of the bureau into a number of divisions, as mentioned hereinbefore, a division of cotton marketing was formed on July 7, 1919, and Mr. D. S. Murph was given general supervision of the following work:

Enforcement of the U. S. cotton futures Act.

Investigation and demonstration of cotton standards,

Cotton testing,

Cotton handling and marketing, and

Marketing cotton seed and its products.

#### ENFORCEMENT OF THE U. S. COTTON FUTURES ACT.

*Investigation of future and spot markets and investigations and quotations of cotton prices at spot markets.*—During the early part of the fiscal year investigational work relating to the cotton futures Act was directed by Mr. George R. Argo, and, after his resignation, in September, by Messrs. Chester Morrill and W. R. Meadows. The work of the project investigation of future and spot markets was done under authority of the United States cotton futures Act, and the work of the project investigations and quotations of cotton prices at spot markets was done under authority of an amendment to the United States cotton futures Act, which was included in the wheat price guaranty Act of March 4, 1919. The work of these projects is of similar nature and has for its purpose the securing of accurate quotations on cotton and giving them the widest possible publicity. The specific objects in view are (a) that cotton of grades other than middling delivered on future contracts, made subject to section 5 of the United States cotton futures Act, may be settled for at actual commercial differences in value, to the end that a proper parity may be maintained between prices of future cotton and spot cotton, and (b) that producers, merchants, and others interested in spot cotton may have accurate information as to the prices of cotton, and particularly grades untenderable on future contracts. The amendments of March 4, 1919, were declared to be permanent legislation in the last annual appropriation act. During the year the supervisory work necessary to insure accuracy and reliability in the quotations of prices from the 10 designated spot markets has been continued.

A cotton price quotation service was inaugurated in the cotton belt, which for the purposes of this work was divided into five districts with headquarters at Charlotte, N. C.; Memphis, Tenn.; New Orleans, La.; Dallas, Tex.; and Atlanta, Ga. Branch offices were opened at Charlotte, Memphis, Dallas, and Atlanta, and the scope of the work of the New Orleans office was broadened to include the

quotation service. At present weekly bulletins containing price quotations and other cotton market information are issued from these five points.

Reports of purchases and sales of cotton are gathered from country buyers, country merchants, dealers, brokers, commission merchants, factors, mills, and others who buy or sell cotton in important country markets and concentration points throughout the belt. On the basis of these reports the weekly bulletins are prepared and published, showing the prices at which the various grades of cotton have actually been bought and sold. The information contained in the bulletins can be obtained by telephone or telegraph by any person who will request such service and pay the transmission expense involved. The bulletins are mailed free of charge to anyone requesting them.

*Determination of disputes.*—During the fiscal year 1920, only 10 disputes were determined. Nine disputes, involving 581 bales, arose out of contracts entered into on the New Orleans Cotton Exchange, and 1 dispute, involving 99 bales, arose out of a contract entered into on the New York Cotton Exchange. The amount of money collected as fees for determining the disputes was \$204. This sum was covered into the Treasury of the United States in accordance with the provisions of the United States cotton futures Act as unamended.

As the last old-style contract (referring to contracts made prior to the amendments of March 4, 1919) outstanding on the New York Cotton Exchange was liquidated on October 24, 1919, and the last old-style contract outstanding on the New Orleans Cotton Exchange on July 25, 1919, there are at present no old-style contracts outstanding. Therefore, no further disputes will be heard.

*Classification of cotton on future exchanges.*—In accordance with the amendments to the United States cotton futures Act contained in the wheat price guaranty Act of March 4, 1919, all cotton delivered on future exchange contracts is now classified by officers of the Department of Agriculture. This work was directed by Mr. Chester Morrill during the fiscal year covered by this report.

On November 6, 1919, the rules and regulations under which the classification work is being conducted were amended so as to provide for a preliminary, informal, sample classification by the Boards of Cotton Examiners at New Orleans and New York. In accordance with this amendment, any owner of cotton who has under consideration the advisability of tendering the same for delivery on a section 5 contract but, before finally determining his course of action, desires the opinion of a board of cotton examiners as to the classification of samples of such cotton, may secure the opinion of such board by submitting the samples to the board and paying the required fee. This informal classification does not obviate the necessity for the regular classification if the cotton is presented for certification for delivery.

During the year 52,585 bales of cotton were classified by the Board of Cotton Examiners at New York, and 56,932 bales were classified by the Board of Cotton Examiners at New Orleans. Of the 52,585 bales classified at New York, only 1,073 bales were submitted to the board a second time for review, and in the review the classification of 50 bales was changed. Of the 56,932 bales classified at New Orleans, only 581 bales were submitted to the board a second time for review, and in the review the classification of 82 bales was



changed. In addition, in the preliminary sample-classification work 2,544 samples were classified by the board at New York and 2,755 samples by the board at New Orleans. During the year the sum of \$43,027.52 was collected as classification fees, including the proceeds from sales of loose cotton, and was deposited to the credit of the revolving fund maintained for the conduct of the work. Disbursements during the year amounted to \$45,876.97. During the month of July following the close of the fiscal year the apparent deficiency above indicated was wiped out. It is intended that the classification work shall be self-sustaining, and for the reason that receipts had been running a little lower than expenses the fees charged were increased during the year. Further changes in the fees, either increases or reductions, may be made from time to time as the relation between receipts and expenditures may warrant.

Effective February 16, 1920, the fee for the classification and certification of cotton, which prior to that date was 30 cents per bale, was increased to 40 cents per bale. Effective May 17, 1920, the fee for the classification and certification of cotton was further increased to 50 cents per bale, and there were minor changes in other fees.

*Preparation and distribution of the official cotton standards.*—The work relating to the preparation and distribution of the official cotton standards was directed by Mr. D. E. Earle. Since the standards for grade and color of upland cotton were promulgated, and up to June 30, 1920, a grand total of 1,276 full white and colored sets and 515 fractional white and colored sets of practical forms had been sold. Three hundred and seventy-two bales of cotton were purchased during the fiscal year for use in the preparation of the official standards. On account of crop conditions it has been increasingly difficult to find suitable cotton for the preparation of the standards.

Since the establishment of the standards for American Egyptian and Sea Island cotton and the standards for length of staple, which were promulgated in 1918, the following sets of practical forms have been sold:

American Egyptian, 62 full and fractional sets.

Sea Island, 11 sets.

Length of staple, 22 full and 150 fractional sets.

During the months of April, May, and June, an inspection was made of the sets held by the designated spot markets, and revisions were found necessary in many cases.

During the fiscal year ending June 30, 1920, \$34,797.69 was covered into the Treasury as miscellaneous receipts, \$20,859.69 from the sale of rejected cotton and \$13,938 from the sale and revision of practical forms of the various standards.

#### COTTON HANDLING AND MARKETING.

Work on cotton handling and marketing was directed by Mr. D. E. Earle and, as at present constituted, is conducted in cooperation with the extension divisions of various States. In a few instances other State agencies join in the cooperative arrangements. A State leader is employed to supervise the work in an entire State and classifiers are employed by the Bureau of Markets and the local organizations, the latter paying the greater part of their salaries and other expenses. The Bureau of Markets participates in the employment of these grad-



ers as a means of conducting its grading demonstrations in the most effective way.

In the course of this work efforts are made to educate producers regarding the value of classing cotton before sale, the use of market quotations, the growing of better varieties of cotton on a community basis, the depressing effect of inferior staple upon prices, and the losses incident to improper ginning, baling, and storage. They are encouraged to organize for the purpose of securing the benefits of community production and marketing of superior cotton.

During the cotton season of 1919-20 approximately 220,730 bales were classed in Texas, Mississippi, Louisiana, North and South Carolina. This work has shown most strikingly the need for more general adoption by communities of a single superior variety of cotton and has made it evident that no marketing association can secure the full benefits of organized effort unless it is handling dependable quantities of a standardized product.

These demonstrations have been attended with most encouraging results; for example, it is conservatively estimated that the farmers of Texas, on account of this educational work, received over a million dollars in premiums for their cotton crop of 1919. At some of the South Carolina towns in which classers were located, it had been the custom to buy all cotton as short staple, but during the past season cotton classed in the course of these demonstrations as a full inch or longer was sold at a premium, thus bringing into the hands of the producers thousands of dollars more than they could have gained under former conditions and emphasizing the desirability of selling according to actual class. A further result in this State has been the withdrawal from the field of many so-called "scalper" buyers whose profits depend largely upon the ignorance of the grower as to the class and value of his cotton.

#### INVESTIGATIONS AND DEMONSTRATIONS OF COTTON STANDARDS AND COTTON TESTING.

Investigations and demonstrations of cotton standards and cotton testing were also directed by Mr. D. E. Earle. The spinning tests were conducted in cooperation with the New Bedford Textile School at New Bedford, Mass., and the North Carolina State College of Agriculture and Engineering at West Raleigh, N. C.

Tests to determine the comparative spinning qualities of Meade and Sea Island cotton indicated that Meade was 5 per cent more "wasty" than Sea Island. Tests are also being conducted to determine the relative strength of the Meade and Sea Island cottons, but they have not been completed. The results thus far obtained seem to indicate that in the higher counts the two kinds of cotton are approximately of the same strength.

Tests conducted in Arizona indicated that Pima cotton stored 30 days or longer was from 5 to 15 per cent stronger than that ginned immediately upon picking, depending upon the size or number of yarn spun.

Tests conducted to determine the relative value of Pima cotton grown in California as compared with that in Arizona indicated that Arizona cotton was from 7 per cent to 20 per cent stronger than the California cotton, depending on the number of yarn spun.

Other tests indicated that soil fertilized with ammonia produced better cotton than that fertilized with acid phosphate or sulphate of potassium, and that cotton which had been infected by the pink boll worm was weakened from 33 per cent to 50 per cent.

A survey of the Sea Island cotton district was made in July, 1919, to ascertain the applicability of the official cotton standards for Sea Island cotton to the past season's crop. This matter was discussed with growers and others interested in handling Sea Island cotton, and some constructive suggestions were made. On account of the fact that the Sea Island cotton industry has been almost destroyed by the boll weevil, however, the use of the standards for such cotton has been greatly decreased.

#### MARKETING COTTON SEED AND ITS PRODUCTS.

Owing to decreased funds, the resignation of the leader of this project, Mr. C. F. Creswell, in October, 1919, and the inability of the bureau to secure the services of a suitable man to fill the vacancy, the work of this project during the past year was largely limited to the compilation of data already in hand. Satisfactory progress in this direction is being made and it is expected that shortly a bulletin will be issued which will set forth some of the results of previous investigations.

#### DIVISION OF GRAIN MARKETING.

The Division of Grain Marketing, after its formation during the past fiscal year, was placed under the supervision of Mr. H. J. Besley. During the period covered by this report this division included the following activities:

- Enforcement of the U. S. grain standards Act,
- Grain investigations.

#### ENFORCEMENT OF THE UNITED STATES GRAIN STANDARDS ACT.

During the past fiscal year the enforcement of the grain standards Act was carried on under the direction of the division leader assisted by Messrs. A. W. Herger, R. T. Miles, and O. F. Phillips.

The official standards for oats, which were made effective on June 16, 1919, have proved to be well adapted to commercial use and generally satisfactory to the various agencies concerned in the marketing of this crop.

The wheat standards have been in effect only during the period of fixed prices, and consequent abnormal marketing conditions. Under the wheat price guaranty Act, the compulsory use of wheat grades applied to intrastate as well as interstate shipments which necessitated the application of the grades to wheat at interior points. As there were no licensed inspectors at these points and as there was a great lack of knowledge regarding grading on the part of producers and many interior dealers, the wheat standards naturally came to be the subject of controversy in some sections. This induced certain persons to recommend, in the spring of 1920, revision of the grades for Hard Red Spring wheat. The proposed revisions involved a distinct lowering of the standards. A delegation from the Central Northwest, favoring these changes, was heard at Washington



on March 19, 1920, and a delegation from the Southwest, opposing the changes, was heard in the same city on March 31. On April 2 an open hearing was held at Chicago at which all interests engaged in the handling of wheat were urged to present their views. For the reasons set forth by the Secretary of Agriculture in Service and Regulatory Announcements No. 62, no changes were made. It is believed that the restoration of normal competitive marketing conditions will practically, if not entirely, eliminate the objections to the wheat grades. The grades for shelled corn and oats have been satisfactory to practically all persons using them, and it is confidently believed that the same would have been true of the wheat grades had they been applied under normal conditions.

Hearings on the tentative standards for milled rice were held in March, 1920, with a view to promulgating these standards under the act, but when the curtailment of funds for the fiscal year 1921 became certain, it was decided not to establish these standards officially and they are consequently used on a permissive basis only.

The district offices at Detroit, Cleveland, and Salt Lake City were discontinued during the year on account of the shortage of funds, and the territory formerly covered from these offices was placed under the jurisdiction of the Chicago, Toledo, and Portland offices. It was necessary to establish new offices at St. Joseph, Mo., and Sioux City, Iowa. The supervision districts have been revised so as to follow county and State lines strictly. This materially simplifies the handling of the work from the standpoint of the licensed inspectors and the grain trade.

Outstanding improvements in service have been effected during the year by strengthening the supervision organization at the larger grain markets. Uniformity of inspection has been materially increased, largely through cooperation between the Federal forces and the forces of the various inspection departments.

More than 120 alleged violations of the act were investigated. Several are now in the hands of the Department of Justice, and findings of the Secretary have been published in other cases or are in course of preparation. Charges were preferred against two inspectors during the year for misgrading grain, and in each case after appropriate hearings the charges were sustained and the licenses of the inspectors were suspended.

At the beginning of the year a total of 405 licenses were in effect and on June 30, 1920, 436 were outstanding. 35 licenses being held in suspension on that date. In a number of cases the new licenses issued were to cover inspection work at new points.

Nine hundred and ninety-six thousand four hundred and forty-two cars of corn, wheat, and oats were inspected by licensed inspectors upon arrival at terminal markets where such inspectors were located, and 496,848 inspections were made on "out" shipments from markets where licensed inspectors were located. In supervising the work of the licensed inspectors, 99,723 samples were handled by district offices located at the principal grain terminals of the country.

Since the food control and wheat price guaranty Acts were in effect during the fiscal year covered by this report, appeals entertained embraced both intrastate and interstate shipments. Ten thousand nine hundred and sixty appeals were filed during the year, of which 1,545 involved intrastate appeals on wheat. Twenty dis-



putes involving grade on interstate shipments between noninspection points were referred to the Secretary of Agriculture. Advance deposits to the extent of \$26,199 were received in connection with these appeals and disputes, of which \$14,007 was covered into the Treasury as miscellaneous receipts, \$12,192 being returned in cases where appeals were not sustained. In addition to the charges assessed for the handling of appeals and disputes, \$9,259.46 accruing from the sale of grain samples was turned into the Treasury as miscellaneous receipts.

Close cooperation was maintained with the United States Grain Corporation in carrying out the terms of the wheat price guaranty Act. The inspection of practically all grain purchased or sold by the Grain Corporation was carefully supervised, and large savings to the Government were effected by insuring correct grading and preventing loss through deterioration in transit and storage.

Demonstrations in grain grading and grain grading schools were held throughout the year. Thirty-four such demonstrations were made at State fairs and 17 at local fairs. At 305 meetings of grain dealers and producers held in various places throughout the country Federal grain supervisors explained methods of grading and inspection and the advantages to be derived therefrom. This work has been attended by excellent results.

#### GRAIN INVESTIGATIONS.

Investigations concerning grain standardization and grain handling and transportation were supervised by Mr. E. G. Boerner. The standardization of barley, rye, and the grain sorghums was given careful consideration and during the past year the work progressed to a point where tentative standards have been drawn up and are being tested in experimental operation in the various field offices to ascertain their applicability to the crops covered.

Progress has been made in determining the extent to which the milling and baking qualities of wheat are affected by admixtures of various amounts of rye, oats, barley, and sorghum grains as well as of objectionable foreign materials.

The increased cost of materials and labor during the last few years has caused the price of grain grading apparatus to advance to such an extent that many grain dealers, especially country dealers, have not felt justified in supplying themselves with apparatus of approved standard design. To meet this condition steps were taken to simplify the design of certain essential pieces of apparatus and these efforts were so successful that the cost of such articles has been reduced from 20 to 65 per cent.

Progress has been made in the grain cleaning investigations by developing methods of removing smut dust and dockage from wheat and other small grains at the thrashing machine. An aspirator was designed for attachment to the grain delivery spout and tests indicate that approximately one-third of the material which ordinarily is classed as dockage may be removed by this device. The use of this device will enable farmers to keep for feed a part of the seeds and other foreign material ordinarily hauled to the elevator and lost to the producer; it also improves the quality of grain by removing

from it a large part of the smut dust and objectionable foreign material. A recleaner, for attachment to the deck of thrashing machines, was also designed and gives promise of being efficient.

Data have been obtained regarding the maximum moisture content which wheat may contain without going out of condition while in transit and storage, and assistance has been rendered in the Pacific Northwest to persons interested in changing from the sack to the bulk method of marketing grain by furnishing plans for the construction of country grain elevators and farm storage bins.

Improved methods and devices for preventing dust explosions and fires in thrashing machines were developed in the Pacific Northwest in investigations carried on in cooperation with the Bureau of Chemistry and Plant Industry. Assistance has been given to the Bureau of Plant Industry by conducting tests to determine the milling and baking qualities of a recently discovered rust-resistant variety of wheat and in connection with the development of methods of eradicating two plant diseases known as "take all" and flag smut. In cooperation with the Bureau of Entomology progress has been made in the preparation of mounts illustrating and describing the various insects to be found in stored grain. Numerous samples of grain were tested for moisture content in connection with the boys' club work of the States Relations Service. Periodical tests were made of oats purchased by the Panama Canal Commission and the War Department, and tests were carried on in cooperation with the Bureau of Animal Industry to determine the feeding qualities of light and heavy weight barley.

#### **DIVISION OF HAY, FEED, AND SEED.**

Mr. G. C. Edler has acted in charge of the work of the division of hay, feed, and seed since Mr. W. A. Wheeler was placed in charge of the information work of the bureau.

During the year the work was divided into two main lines:

Investigations concerning the marketing of hay, feed, and seed.

Market news service on hay, feed, and seed.

#### **MARKETING HAY, FEED, AND SEED.**

The division leader was assisted in conducting this work by Messrs. H. B. McClure and G. C. Wheeler.

The marketing of hay was studied at country points, in terminal markets, and in consuming territories and the standardization of this crop was carefully considered from every possible angle. The information gained in the course of this study has created an emphatic realization of the need for Federal hay grades and a Federal hay inspection service. The marketing of hay is a most unsatisfactory undertaking on account of lack of inspection, variation in grades in different markets, differences with which grading rules are interpreted, and other factors. While the bureau has been given specific legal authority to conduct a hay inspection service, no funds have been provided for the work.

Effort was made to determine the possibility of improving the reports now issued regarding seed production and movement, and to ascertain the sources from which farmers obtain seed. State seed

laws have been compared with the proposed uniform seed law, which has been approved by the Association of Official Seed Analysts of North America and the American Seed Trade Association, to determine the important differences existing between them.

#### MARKET NEWS SERVICE ON HAY, FEED, AND SEED.

Mr. G. A. Collier assisted the division leader in the conduct of the market news service on hay, feed, and seed.

During the year this work was curtailed and branch offices are now maintained at Chicago and Kansas City only. During the early part of the year they were maintained at Chicago, Minneapolis, Kansas City, San Francisco, Spokane, and Atlanta. Since January, 1920, reports covering supply, demand, movement, and prices of hay, feed, and seed at more than 15 of the principal markets have been issued from Washington in *The Market Reporter*. At the two branch offices first-hand information regarding market conditions in the field is obtained and sent to Washington, where it is embodied in the published reports. Special reports relating to seed production and shipment were published during the year.

#### MARKETING STATISTICS.

Elsewhere in this report the development of a statistical section in the Bureau of Markets was discussed. Dr. C. J. West was placed in charge of this section in March, 1920. The statistical work of the bureau has been carefully surveyed; work preliminary to the preparation of a complete statistical summary for all projects has been done; tables have been planned and arranged for publication in *The Market Reporter*; and assistance has been given to various projects in devising the best methods of compiling and tabulating data.

#### DISSEMINATION OF MARKET INFORMATION.

The need for distributing the market information from the bureau in an increasingly effective manner was discussed in the first part of this report. As a step in this direction a division of market information was organized on March 16, 1920, and Mr. W. A. Wheeler was given general supervision of all information work for the bureau. This division now supervises the editing and issuance of all printed publications or bulletins of the bureau, including *The Market Reporter*; the preparation or approval of all news items concerning the work of the bureau; and the preparation and display of all bureau exhibits, photographs and lantern slides, motion pictures, etc.

#### COSTS OF MARKETING FARM PRODUCTS.

In the summer of 1919 a special investigation of the retail meat trade was begun under the direction of Mr. Herbert C. Marshall, assistant chief of the bureau, and is in progress at the present time. It is expected that this investigation will make available a large amount of information relative to the prevalence and comparative numbers of the various types of shops, such as straight meat market, combination grocery and meat market, stall in public market, and



chain store; the relation of number of dealers to population in various communities and parts of the country; municipal abattoirs and the relation of local slaughter to the retail trade; methods of sale and meat distribution in rural districts; the extent to which systematic accounting is utilized and various methods of advertising employed; the comparative prevalence of cash and credit and of delivery and nondelivery trade; costs of operation in the various types of stores and under the various methods of operation; sanitary conditions and State and local regulations; the relation of retail to wholesale prices and the methods followed by retailers in adjusting their business to sudden changes in wholesale prices; and various other matters of interest.

The reports prepared by this bureau regarding the cost of marketing live stock and grain were described in the annual report for last year. In December, 1919, that concerning live stock was published by the Federal Trade Commission as part 6 of its report on the meat-packing industry. Mr. C. S. Cole, who had been in charge of this work, was detailed to the Joint Congressional Committee on Reclassification during the past fiscal year and in June resigned from the bureau. The leadership of this line of work was then placed in the hands of Dr. L. H. Haney, who is now conducting the studies concerning the cost of marketing mentioned elsewhere.

#### MARKET BUSINESS PRACTICE.

The work relating to Market Business Practice is conducted under the general direction of Dr. L. H. Haney.

This project, which last year was under the immediate direction of Mr. A. V. Swarthout, was somewhat retarded by the fact that several of the accountants on the staff were detailed to assist with the retail meat investigation just described, and that several others resigned. Our inability to obtain well-qualified workers to fill the places left vacant prevented the completion of some of the work described in last year's report and precluded the commencement of some new activities.

Investigations were made in the Pacific Northwest as a basis for outlining a standard accounting procedure for fruit shipping agencies, and for devising effective cost records for community fruit packing houses. As a result of this work, a classification of accounts for fruit shipping organizations has been prepared.

In the Connecticut Valley investigations were made to determine the accounting needs of cooperative tobacco warehouses, and a system of accounts for such agencies has been prepared and will be ready for the printer shortly. This system is intended for temporary use, pending the preparation of a more complete one.

Investigations were made to determine the most effective procedure for auditing the accounts of grain elevators and to determine the type of accounts best adapted for use in sweet-potato warehouses.

The work mentioned in last year's annual report, relating to accounts for cooperative stores, milk plants, and commission houses, was continued, and bulletins summarizing the results should be issued within a relatively short time.

Demonstrations showing correct methods of accounting to be made by means of short courses for bookkeepers and managers of market-

ing agencies were mentioned in last year's report. These courses were prepared and the number of students who are recorded as enrolled for study is now 195. It is known that five colleges are giving such courses and, from indirect reports, evidence is at hand that several other institutions have used the material sent to them.

As a practical demonstration the accounting force installed systems of accounts in six creameries and in five grain elevators. Other installations were made for experimental purposes.

#### COOPERATION WITH THE STATES IN MARKETING WORK.

During the fiscal year ending June 30, 1920, the Bureau of Markets cooperated with 31 of the 48 States in the conduct of marketing work—a larger number than ever before. These States were: Arkansas, California, Colorado, Connecticut, Delaware, Georgia, Indiana, Iowa, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Mexico, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, and Washington.

In 21 States cooperative arrangements were made with the agricultural college; in 6 with the State division of markets or State department of agriculture; and in 4 with both the agricultural college and the State division of markets.

The work in each State is performed under the immediate leadership of an agent in marketing, whose function it is to assist in coordinating the marketing activities of the various agencies in the State in which he is located and to give practical assistance in solving the marketing problems of his territory. The majority of these agents have assistants engaged on special phases of marketing. The great importance of this work lies in the fact that it affords a means for developing a consistent national marketing policy. Viewed as a whole, distribution is fundamentally an interstate activity and should be handled on a national basis. Marketing work has been taken up at a very recent date, relatively speaking, and State officials, in common with others, are anxious to develop it along lines that will bring substantial benefits both to producers and consumers. Leaders seem to be agreed that the most promising line is one looking toward a consistent, interknit, national policy that will prevent duplication of effort, cross-purposes, and conflicting currents of trade. Many States also wish to coordinate existing official marketing agencies within their borders. The Federal agents bring to the agencies within the States information relative to the work done by the Federal Bureau of Markets and constitute a channel for making this information available in a prompt, concrete, and direct way. They encourage cooperation within the States themselves and make available to the Federal bureau the results of the work done in the States.

While complete figures are not available relative to the work of the agents in marketing, those at hand show that they assisted producers to form 183 marketing organizations, including 50 live-stock shipping associations; 57 fruit and vegetable associations; 12 credit unions; and 19 federations of existing associations. One hundred and thirty-eight groups of producers were assisted in making cooper-



ative sales, many of which comprised one or more carloads of live stock. One of these sales involved 417 head of cattle, which, it is stated, were sold for \$2,508.97 more than they would have brought had their owners placed them on the market individually on the day of the sale. Assistance in organization or grading was given to 166 wool pools, which handled over 10,000,000 pounds of wool. Co-operative enterprises in three States were given assistance in solving their accounting problems.

Instructions as to the most successful practices for marketing sweet potatoes were given to producers and shippers in most of the Southern States and in one of the far Western States. In one State plans and specifications for sweet-potato storage houses were furnished, and 53 storage houses based on these plans and specifications were erected.

Exhibits illustrating approved marketing practices were made in six States. Assistance was given to State agencies in instituting local market reporting services. The collection and distribution of information relative to quantity, quality, and prices of locally-grown produce was arranged for at 11 points in 4 States.

Nearly 200 demonstrations of approved practices of preparing farm products for market were made and over 700 lectures bearing upon the packing, grading, handling, storage, and sale of farm products and other matters were given.

In a number of States the field agents, through State agencies, were instrumental in bringing about the adoption of Federal standards for farm products and containers. In all States assistance was given to the county agricultural agents in solving difficult local marketing problems.

This work was supervised by Mr. C. W. Thompson until his death on February 2, 1920, since which time Mr. R. H. Elsworth, who was in immediate charge of the work in the Northern and Western States, has acted as project leader. Mr. G. O. Gatlin immediately directs the work in the Southern States.

#### FOREIGN MARKETING.

In the spring of 1920, Mr. W. R. Sibley, who succeeded Mr. C. W. Moomaw as leader of this project, resigned and Mr. E. G. Montgomery was placed in charge of our foreign marketing investigations. The leader of this project, aside from his regular duties, represents the Department of Agriculture on the Economic Liaison Committee at the State Department, which is designed to coordinate the efforts of the various agencies of the Government so far as they are concerned with foreign trade, to prevent overlapping and duplication, and to provide a means for a helpful interchange of views.

In the first part of this report will be found a rather full discussion of an expedition which the bureau sent to South America in June, 1919, and of the work of the agricultural commissioner who has been maintained in London since May, 1919. The expedition to South America was led by Mr. David Harrell, a live-stock breeder of standing and experience, and representative of the United States War Trade Board at Barcelona, Spain, from November, 1917, to January, 1919.



Information contained in reports of the Consular Service and other Government agencies and in publications from all countries has been compiled and classified, an average of 75 publications and 100 consular reports having been reviewed and indexed weekly. Statistics concerning the production, consumption, exports, imports, supply, and prices of agricultural products of all countries have been compiled and converted into terms of American units.

Until the discontinuance of this work at the end of August, daily and weekly reports of the exports and imports of important agricultural products at New York were compiled from ships' manifests filed in the New York customhouse. These data are considered very valuable both by the trade and trade publications, and their publication should be resumed when funds become available.

From July to December, inclusive, a circular entitled Reports on Foreign Markets for Agricultural Products was published weekly, but on the publication of The Market Reporter on January 3, 1920, this circular was discontinued, and much of the information on foreign conditions formerly published therein has been included in the foreign section of the new publication.

#### COOPERATIVE MARKETING OF FARM PRODUCTS.

During the first part of the fiscal year work relating to cooperative marketing was supervised by Mr. C. W. Thompson, assisted by Mr. O. B. Jesness. Since Mr. Thompson's death, in February, 1920, Mr. Jesness has directed this work. Investigations of cooperative organization problems were made and assistance was given to producers in their solution. This work was conducted in 40 States and included producers of grain, live stock, dairy products, fruits, vegetables, wool, cotton, tobacco, nuts, honey, and other products.

In addition to the assistance given to cooperative purchasing and marketing associations, advisory aid was given in connection with the formulation of plans for a national federation of live stock shipping associations, a similar State association, and a State federation of farmers' elevators.

Conferences were held with secretaries of State farmers' grain dealers' associations, and as a result a suggested set of by-laws for cooperative grain elevator companies was prepared.

An investigation of the cooperative marketing of grain was made in western Canada for the purpose of obtaining information of value to farmers of the United States in formulating plans for cooperative grain marketing in this country.

Information concerning the cooperative movement among farmers in the United States was gathered to supplement that already on file and suggestions regarding cooperative legislation were given upon request in a number of instances. The suggested law, which was prepared by the bureau and published in 1917, has served as a guide in the enactment of cooperative legislation in at least four States up to the present time.

#### TRANSPORTATION OF FARM PRODUCTS.

The transportation work of the bureau has been directed by Mr. G. C. White ever since its institution. During the past year he was

assisted by Mr. J. G. Cross. Since the beginning of the war this bureau has been called upon to an increasing extent for assistance in the solution of traffic problems. Appeals for assistance in securing better transportation service come not only from producers and distributors of agricultural products but from manufacturers of agricultural machinery, and the commodities used in agricultural production, and others. Besides the assistance given to the public the other bureaus in the department have received help in connection with their work. The correspondence arising in connection with these matters has been so heavy that practically the entire time of one of our transportation assistants has been required to handle it.

As in previous years, a great deal of attention was necessary to keep on a satisfactory basis our arrangements with the carriers, who cooperated most willingly in furnishing the reports which are used in connection with the market news service. Five hundred and ninety-two common carriers made reports to the bureau in the year covered by this report. These carriers control 248,722 miles of railroad or boat lines, which, for practical purposes, constitutes the entire mileage of the United States. To insure the prompt, accurate, and satisfactory transmission of these reports involves a large amount of travel on the part of our transportation staff.

Transportation men were detailed to certain producing sections to assist in moving heavy crops of fruits and vegetables at time of harvest. These men worked in close cooperation with shippers and carriers to bring about the best possible utilization of transportation equipment. Work of this sort is of practical and direct value to producers and carriers and of indirect value to the entire country.

#### DIVISION OF WAREHOUSING.

The Division of Warehousing was formed so that problems related to this important phase of marketing might be properly correlated.

At present the work which would naturally fall under this division includes that done in connection with the enforcement of the United States warehouse Act and the issuance of the cold-storage reports.

During the past year a project entitled cotton warehousing investigations was also maintained and, therefore, will be included in this report although it has been discontinued on account of decreased funds.

#### ADMINISTRATION OF THE UNITED STATES WAREHOUSE ACT.

During the fiscal year covered by this report, this work was directed by Messrs. D. S. Murph, Chester Morrill, and R. L. Nixon.

*Cotton.*—At the close of the fiscal year licenses had been issued to 24 warehousemen. Two of these licenses, however, have expired, so that 22 cotton warehouses are now operated under the United States warehouse Act. Twelve persons have been licensed to classify cotton and five persons have been licensed to weigh cotton under the act. During the year applications were received from 106 cotton warehousemen. Prior to this 34 applications had been received, making a total of 140. As indicated, 24 of these applicants have been licensed; other applications have been approved and licenses will be issued when bonds are received. Increasing interest in the licensing



of cotton warehouses has been shown, and, it is thought, is due to the following facts:

The Atlanta Federal Reserve Bank is actively encouraging warehousemen to become licensed and bonded under the United States warehouse Act and a cooperative agreement has been entered into with the Georgia State Bureau of Markets, whereby the State bureau furnishes a free grading service to all licensed warehousemen who desire it. The governor of the Federal reserve bank at Dallas has recently taken an active interest in the act and is circularizing member banks in his district in advocacy of the Federal system of warehouses. Very substantial reductions in the rates of fire insurance on licensed warehouses have been granted by the various rating bureaus in the South. In a majority of Southern States this reduction amounts to 25 per cent from the scheduled rates; in other Southern States the reduction ranges from 25 per cent on certain classes of warehouses to 10 per cent on others. Ten per cent is the minimum concession. The Federal Farm Loan Board has approved forms of receipts to be used under the regulations and steps have been taken to secure like approval from the Federal Reserve Board.

The bureau has cooperated as far as possible in view of limited funds and personnel with the officials of the American Cotton Association, and many of them are encouraging the construction and licensing of warehouses. An agreement was entered into with this association, the State warehouse commissioner of South Carolina, and the State extension service of South Carolina looking to the organization of farmers' associations and among other things, the acquirement of adequate cotton warehousing facilities in that State.

In the last annual report, reference was made to cooperation between this bureau and the State of North Carolina in the operation of its State warehouse law. Experience proved the necessity of certain amendments to this law, which, it is thought will be made in the near future, and doubtless will result in the licensing and bonding under the United States warehouse Act of all warehouses operated under the State system. State officials in Alabama asked for the assignment of representatives of the bureau to that State for the purpose of discussing the warehouse act with warehousemen and producers and answering their inquiries, and although the pressure of work did not permit full compliance with this request, numerous applications for licenses were received and the State officials were of the opinion that more would be received if their requests could be met.

*Grain.*—Regulations for grain warehouses were promulgated and brought before the public in the late fall of 1919. Applications for licenses have been received for 174 grain warehouses. Ninety-seven persons have applied for licenses to inspect grain under the act and 122 persons have made applications to weigh grain under the act. At the end of the fiscal year, 9 licenses had been issued and 50 applications had been approved, and licenses will be issued to those applicants as soon as the necessary bonds are received. In this connection, it must be borne in mind that an inspector of this bureau must personally examine the warehouse and the business methods and accounts, as well as inquire into the finances and reputation, of each warehouseman who files an application, before a license can be issued.



In California the State superintendent of weights and measures has expressed his desire to cooperate with this bureau in its work in his State. He has made changes in the State form of weigher's certificate and warehouse receipts to eliminate a conflict which previously existed with the requirements for forms of this kind used under the United States warehouse Act and has agreed to cooperate with this bureau in the use of warehouse inspectors.

In Idaho the officers of the largest farmers' cooperative grain elevator organization in the State have undertaken to have their warehouses licensed under the warehouse act and to take active steps to procure legislation in that State which will make the operation of the warehouse act more effective.

Influential persons in North Dakota and Arizona have thoroughly investigated the operation of the act and have agreed to cooperate in the work.

*Wool.*—Public hearings on the tentative regulations for wool warehouses were held throughout the country during the month of February, 1920. On June 18, 1920, final regulations for wool warehouses were promulgated. The necessary application and inspection forms have been completed and inspections will be made as applications are received. On account of the critical situation in the wool market many inquiries in regard to the act were being received at the close of the fiscal year.

*Tobacco.*—Regulations for tobacco warehouses have not been completed on account of the resignation of the man in charge of this part of the work and the unavoidable delay in filling his position. At the end of the fiscal year, however, the tentative regulations for tobacco warehouses were nearing completion and public hearings were contemplated.

#### COTTON WAREHOUSING INVESTIGATIONS.

After publication of the last annual report it was found necessary to make additional tests to determine the extent of damage to baled cotton from exposure to the weather. It is hoped that the results of these and the tests which were mentioned in the last annual report as having been concluded will be ready for publication at an early date.

The standard cotton warehouse designs have been brought to the attention of interested persons in an effort to promote the building of warehouses in accordance with the most advanced ideas regarding construction, fire protection, etc. Models of the various types of standard warehouses have been prepared for educational purposes. It is believed that this work, which was supervised by Mr. R. L. Nixon, will result in savings in insurance costs and in better warehouse service.

#### COLD STORAGE INVESTIGATIONS AND REPORTS.

As Mr. I. C. Franklin was detailed to the War Department during the emergency period, investigations of cold-storage problems have necessarily been held in abeyance. Mr. Franklin has now returned to the bureau and the investigations will be resumed.

The cold-storage reports issued by the Bureau of Markets cover certain food commodities handled by cold-storage warehouses and

packing plants, including boxed and barreled apples, creamery and packing-stock butter, 7 varieties of cheese, case and frozen eggs, 5 classes of frozen poultry, 9 varieties of frozen and cured meats, lard, 23 varieties of frozen fish, and 2 varieties of cured fish. They furnish information showing the stocks on hand for the 1st day of each month, except for the reports on fish, which show the holdings of the 15th of the month. The excellent cooperation received from cold-storage and packing plants makes it possible to compile very complete and accurate reports.

During the year the reports were amplified to show the receipts and deliveries each month and the quantities of cured meats and lard manufactured monthly.

The discontinuance of the practice of obtaining information by telegraph from storages in the Pacific Coast States on account of insufficient funds makes it impossible to issue the reports until the 15th of the month, whereas formerly they were published on the 10th. The value of the reports is considerably enhanced when publication is made at the earlier date.

#### PRESERVATION OF FRUITS AND VEGETABLES IN TRANSIT AND STORAGE.

Work on the preservation of fruits and vegetables in transit and storage during the fiscal year covered by this report was supervised by Mr. C. W. Mann. Although excellent progress was made, it was necessary practically to discontinue several important lines of investigation and demonstration on account of curtailment of funds.

Investigations of handling apples and pears in the course of harvesting, packing, and transporting, and the determination of the stage of maturity at which they should be picked, were begun; also investigations to determine the factors responsible for the decay and deterioration in shipments of these fruits from the Pacific Northwest. A study of the methods of precooling and refrigerating California oranges was undertaken in cooperation with the California Fruit Growers' Exchange. The results of the precooling investigations should be of very great value to the citrus industry, both in California and Florida, as well as to the deciduous fruit industry in various parts of the country. In other investigations it was found that brown rot in peaches could be materially reduced by more effective refrigeration. It was also found that injuries resulting from improper methods of harvesting and handling in the field and in storage were responsible for much of the early decay of sweet potatoes. Better methods have been extensively demonstrated to growers and shippers in producing sections.

In cooperation with the United States Railroad Administration a survey was made of railroad icing stations in the eastern Central States, which brought forth information as to the economy and efficiency of ice storages and icing equipment, methods of operation and other factors. Information has been furnished shippers regarding the proper methods of lining, loading, and heating cars used for the shipment of potatoes, apples, and other products during the winter months.



Experiments with reference to the handling and storage of California table grapes confirmed the results of the tests made during the previous season, and showed that spruce sawdust is a suitable and commercially satisfactory packing material. More than 80 cars of Emperor grapes packed in spruce were shipped in the fall of 1919.

For several years demonstrations have been made in the Pacific Northwest to point out proper methods of constructing and operating apple storage houses. With the rapidly increasing production of apples in this region there has been an acute shortage of refrigerator cars to move the crop from producing sections, and there has been an insistent demand for information concerning the proper design, insulation, and ventilation of both common storage and cold storage warehouses. During the present season assistance has been given growers and shippers in providing additional common storage houses for 1,220 carloads of apples and cold storage houses of 800 carloads capacity. Effective work was done by assisting sweet potato growers to build more than 500 new storage houses having an average capacity of about 2,500 bushels. The combined capacity of efficient storage houses for sweet potatoes built during the last three years in accordance with recommendations of the department, amounts to approximately 5,000,000 bushels. Data were secured regarding the temperature and humidity which should be maintained in storage houses for the most effective curing and storage of sweet potatoes.

Additional data have been secured concerning the freezing points of fruits and vegetables. The effect of low temperature on sweet potatoes, tomatoes, and other fruits and vegetables was studied to determine the proper methods of handling products injured by chilling or freezing in order that they may be utilized as food. Through this work it has been possible to obtain fundamental information regarding suitable temperatures for the cold storage of fruits and vegetables. It was demonstrated that by holding California table grapes at 28° to 30° F. instead of 32° (the ordinary temperature used in commercial storage), the storage period may be lengthened by at least 30 days, thereby materially extending the marketing season. Experiments are being carried on to determine the safe minimum storage temperature for apples, lettuce, celery, and other fruits and vegetables.

Investigations concerning the preservation of fruits and vegetables by freezing storage were continued. The factors affecting the keeping of these products and the influence of temperatures ranging from 20° F. to -5° F. on the quality and condition of frozen berries, plums, cherries, beans, sweet corn, and other fruits and vegetables were studied. A more extensive utilization of freezing storage seems entirely practicable and desirable in many of the larger market centers where surplus stocks of highly perishable fruits and vegetables are available.

#### COMPLETION OF THE WORK OF THE DOMESTIC WOOL SECTION OF THE WAR INDUSTRIES BOARD.

For the completion of the work of the Wool Division of the War Industries Board the sum of \$35,000 was appropriated for the fiscal year 1920. This work was directed by Mr. Wells A. Sherman.



Up to June 30, 1920, more than 4,500 complete reports of 1918 wool transactions had been received from country dealers. In addition, detailed reports were finally secured from 178 distributing-center dealers who operated in the year 1918. In only 76 reports from central dealers were found evidences of excess profits, and the audit of the reports from country dealers has disclosed only about 1,000 cases of excess profits—slightly over 20 per cent. A total of \$336,235 has been collected on account of excess profits—\$181,743 from the central dealers and \$154,492 from country dealers. Refunds to wool growers to June 30, 1920, have amounted to \$3,908. The balance of the money which has been collected, as well as that which remains to be collected as a result of future audits, will be held in the Treasury and distributed to those growers to whom refunds are due at some date in the near future.

Various difficulties have attended the prosecution of this work. The question of liability of dealers to the payment of income taxes has been the subject of considerable correspondence and numerous conferences, and it is not yet fully settled in all of its details. The destruction of records by fire and flood has delayed or abridged many reports and has made it impossible to obtain others. The dissolution of corporations and firms that operated in 1918 and the death of individuals who operated as country dealers without keeping a complete set of books presented difficult situations, and in more recent months it has been necessary to make extensive audits of accounts in the field. Although these difficulties have been encountered, it has not thus far been necessary to file suits, and it is hoped that the work of the domestic wool section may be entirely completed without appealing to the courts.

#### DIRECT MARKETING.

The general purpose of this work, which was supervised by Mr. L. B. Flohr, was to ascertain, analyze, and classify the factors bearing on the success of marketing farm products from producer to consumer direct by parcel post or express; also to determine the limitations of direct marketing, both from physical and economic standpoints. On account of the general reduction in funds it was necessary to discontinue this project on June 30, 1920.

During the year covered by this report, 568 experimental shipments of 16 different commodities were made by parcel post and express. The aggregate weight of these shipments was 13,268½ pounds and the mileage they covered was 77,755. During the year field studies were made in western New York with Rochester as the principal center and in Detroit, Lansing, Flint, Pontiac, Grand Rapids, Saginaw, and Port Huron and surrounding country. The results of experiments have shown that, in the great majority of cases, the success of a shipment, so far as satisfactory delivery is concerned, depends on properly grading and standardizing the product shipped, on using an appropriate type of container, and necessary care in packing and transportation and, finally, on the length of time the shipment is in transit. The value of a commodity in proportion to its weight and the price which can be obtained for it in comparison with prices obtainable otherwise are factors to be considered in determining the desirability of direct marketing.

General economic conditions with high wages, scarcity of labor, and abundance of money in circulation, have not in the last few years been such as to induce either producers or consumers to take advantage of such savings as may be effected by marketing direct from the producer to the consumer.

### CITY MARKETING AND DISTRIBUTION.

At the request of municipal officials, city planning commissions, market committees, farmers, and other interested parties, surveys looking to the establishment of better marketing systems for perishable farm products were made in Memphis, Tenn., Atlanta, Ga., Kansas City, Mo., Freehold, N. J., and Indianapolis, Ind. In each case recommendations were made to the municipality on the facts determined in the survey. Plans for improving the market in Savannah, Ga., were considered at a conference attended by representatives of the city of Savannah and of this bureau. After the conference, the bureau representatives suggested certain modifications in these plans and furnished sketches embodying their ideas. Advice was given by correspondence to other communities which could not be visited.

In many of the communities mentioned above investigations were made of existing marketing systems and of methods employed in the distribution of certain products. Desirable and undesirable points were noted and data were collected for use in service work and for incorporation in bulletins which were in course of preparation. Similar investigational work was carried on in Detroit, Mich., where promising activities are under way looking to the development of a complete municipal marketing system; and in Toledo, Ohio; Indianapolis, Ind.; Cincinnati, Ohio; Rochester, N. Y.; St. Louis, Mo.; Allentown, Pa.; Adrian, Mich.; and Welborn, Kans. Data were collected from other communities by correspondence.

This work was directed by Mr. McF. Kerbey. On account of the general reduction in funds, it was necessary to discontinue the project on June 30, 1920.

### PUBLICATIONS DURING THE YEAR.

#### DEPARTMENT BULLETINS.

- 825. Rural Community Buildings in the United States, 1920.
- 857. A Modified Boerner Sampler, 1920.
- 860. The Organization of Cooperative Grain Elevator Companies, 1920.
- 861. Marketing Eastern Grapes, 1920.
- 864. A Peach Sizing Machine, 1920.
- 865. A Classification of Ledger Accounts for Creameries, 1920.
- 873. Shrinkage of Market Hay, 1920.
- 882. Manufacturing and Laboratory Tests to Produce an Improved Cotton Airplane Fabric. 1920. (In press.)

#### FARMERS' BULLETINS.

- 1080. Preparation of Barreled Apples for Market. 1919.
- 1091. Protection of Potatoes from Cold in Transit—Lining and Loading Cars. 1919. (Revision of Markets Document 17.)
- 1118. Dockage under Federal Wheat Grades. 1920.
- 1134. Castrating and Docking Lambs. 1920. (In cooperation with the Bureau of Animal Industry.)
- 1144. Cooperative Marketing. 1920.

## YEARBOOK SEPARATES.

- 797. How to Use Market Stations. 1920.
- 809. Federal Supervision of Live Stock Markets. 1920.
- 811. Why Produce Inspection Pays. 1920.
- 818. Selling Pure-Bred Live Stock to South America. 1920. (In press.)
- 819. The Farmer's Purchase Power: How Organized. 1920. (In press.)
- 821. Live Stock Conditions in Europe. 1920. (In press.)

## OFFICE OF THE SECRETARY, CIRCULARS.

- 141. Regulations of U. S. Warehouse Act of August, 1916, as amended July, 1919. Revised Regulations for Grain Warehouses. 1919.
- 143. Regulations of U. S. Warehouse Act of August, 1916, as amended July, 1919. Revised Regulations for Cotton Warehouses. 1919.
- 144. Rules and Regulations of the Secretary of Agriculture under the Food Products Inspection Law of July 24, 1919. 1919.
- 150. Regulations of U. S. Warehouse Act of August 11, 1916, as amended July 24, 1919. Regulations for Wool Warehouses. 1920.
- 151. Rules and Regulations of the Secretary of Agriculture under the Food Products Inspection Law of May 31, 1920. 1920.  
Service and regulatory announcements, Grain standards Act: 52, 54-56, 58-60, 62-64, 65.  
Warehouse Act: 53, 61, 57, 66.

## DEPARTMENT CIRCULARS.

- 56. Suggested Improvements in Methods of Selling Cotton by Farmers. 1919.
- 95. United States Grades for Northern Grown Onions. 1920.
- 96. United States Grades for Potatoes. 1920.
- 97. United States Grades for Bermuda Onions. 1920.
- 98. The Installation of Dust-Collecting Fans on Thrashing Machines for the Prevention of Explosions and Fires and for Grain Cleaning. 1920.
- 99. United States Grades for Sweet Potatoes. 1920.
- 133. United States Grades for Milled Rice: Recommended by the United States Department of Agriculture. 1920.

## MARKET REPORTER.

(Weekly.)

Vol. 1, No. 1, January, 1920—date.

## MISCELLANEOUS.

- U. S. G. S. A. Form No. 107. Handbook. Official Grain Standards for Oats. June, 1919.
- U. S. G. S. A. Form No. 90. Revised Handbook. Official Grain Standards for Wheat, Shelled Corn, and Oats. June, 1919.





## REPORT OF THE CHIEF OF THE OFFICE OF FARM MANAGEMENT AND FARM ECONOMICS.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
OFFICE OF FARM MANAGEMENT AND FARM ECONOMICS,  
*Washington, D. C., October 7, 1920.*

SIR: I am submitting herewith the annual report of the Office of Farm Management and Farm Economics for the fiscal year ended June 30, 1920.

Respectfully,

H. C. TAYLOR,  
*Chief.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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The work of the Office of Farm Management and Farm Economics, as outlined by the committee on reorganization in February, 1919,<sup>1</sup> has been vigorously pushed during the fiscal year just closed. Two important preliminary studies in the cost of production have been completed (wheat and cotton), a third (beef cattle) has been brought to the point of final tabulation, and a fourth (sugar beets) is now well under way. A study of the Iowa "land boom" has been completed, also an investigation of hail insurance. Field work has been done in over a score of surveys of different kinds, including business analysis surveys, farm life surveys, and studies of the economic aspects of ownership and tenancy. A study of the use of motor trucks on eastern farms has been completed. While important results have been secured, a number of projects outlined by the committee on reorganization, notably farm labor, rural credit, and taxation, have not as yet received adequate attention, owing to lack of funds.

### COST OF PRODUCTION AND FARM ORGANIZATION.

Studies in the cost of producing farm products have emphasized the wide variation that exists on individual farms in the cost of producing any product and the danger that exists in using the average as an expression of cost results. For example, the average cost of wheat per bushel on the 481 farms studied during the year was \$2.51, but more than 50 per cent of the farmers concerned produced wheat at a cost above this figure, ranging up to an extreme of \$8.20 per

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<sup>1</sup> Circular 132, Office of the Secretary.

bushel. Similarly, the average cost of cotton for the 842 farms studied was approximately 23 cents per pound, yet almost 60 per cent of the growers had costs above this average. The results of cost studies are now presented in the form of frequency tables in order to show the proportion of a product that is produced at or below a given cost and to call attention to the importance of bulk-line cost rather than average cost in relation to price.

In carrying forward the studies in the cost of producing farm crops, records were obtained during the year as follows:

Cost of producing sugar beets in Utah and Idaho-----	175 records.
Cost of producing wheat in Kansas, Missouri, Nebraska, Minnesota, North Dakota, and South Dakota-----	481 records.
Cost of growing cotton, together with a complete farm-business analysis in Alabama, Arkansas, Georgia, Mississippi, South Carolina, and Texas-----	846 records.

Preliminary reports on the cost of producing cotton and wheat have been issued. A bulletin on the cost of producing cotton in 1918 has been submitted for publication, and there is in preparation a bulletin on the cost of growing wheat. The sugar-beet records have been tabulated, but the results of this study will not be published until additional records, to be obtained during the current year, have been tabulated.

Investigations into the cost of fattening cattle have progressed so far that early publication of results may be expected. Active field work in this study was not started until September, 1919, at which time cooperative studies in the cost of fattening cattle were inaugurated with Indiana, Illinois, Iowa, Nebraska, and Missouri. In the fall of 1919 a cost-of-cattle-fattening enterprise survey was made on 321 farms and a complete farm-business analysis study made on 269 of the 321 farms visited.

Detailed cost-accounting routes of cattle feeding farms were formed in each State, consisting of approximately 25 farms each, and all were successfully carried to completion of the year's work, which ended about July 1, 1920. This gave a total of 126 farms for the five States. A complete business analysis was obtained on the detailed cost-accounting farms, and in the month of June, 1920, two areas were visited in the States of Iowa and Nebraska, and up to the 1st of July 100 farm business analysis studies had been completed, together with the same number of cost-enterprise records on the same farms.

Farm business analysis surveys were completed as follows:

Two general crop and live-stock areas in Iowa-----	400 records.
A fruit and truck area in Florida (third year of study)-----	300 records.
A general farming area in New Hampshire (repeated after a 10-year period)-----	136 records.
A general farming area in Ohio (eighth year of study)-----	50 records.
A fruit district in Virginia (fourth year of study)-----	100 records.
A cooperative tractor and farm organization study in two areas in Ohio (second year of study)-----	100 records.

Cooperative cost accounting studies have been conducted by the route plan in the States of Kentucky, Ohio, Kansas, Montana, Minnesota, and New Jersey. In the States of Kentucky and New Jersey specialized types of farming have been selected, namely, tobacco farms in Kentucky and tomato and potato farms in New Jersey.



In the former State the tobacco crop on 75 farms in each of two areas has been intensively studied, with a complete farm survey record taken on many of the farms at the end of the year. In New Jersey about 160 enterprise survey records were obtained on tomato and potato farms, and about 40 farms were started on detailed accounting on the entire farm business.

In Ohio, Kansas, Montana, and Minnesota a total of 150 farms are cooperating in reporting complete details of the farm operation. Ohio is maintaining two routes of from 20 to 24 farms each; Kansas, two routes of about the same number; Montana, one route of 20 farms; and Minnesota, two routes of 24 farms each.

A study of the use of farm motor trucks was inaugurated and completed in the Division of Farm Equipment, and tabulations have been made of 8,000 replies to a questionnaire.

### LAND ECONOMICS.

In cooperation with the Iowa State College of Agriculture, an investigation was made of the phenomenal advance in land values that took place in Iowa during the spring and summer of the year 1919. It was found that the average value of Iowa farm lands increased \$121 per acre in the five years from 1915 to 1920, and that \$63 of this increase occurred between March, 1919, and March, 1920, the twelve-month including the period of the boom. Over 65 per cent of the buyers and over 56 per cent of the sellers were farmers, while, contrary to general belief perhaps, less than 7 per cent of the buyers and but a little over 11 per cent of the sellers were real estate men. The facts brought out relative to per cent returns on investment in these lands make it clear that they are valued in excess of their earning capacity. The investigators point out that with land paying but 3 per cent on capitalization and loans running at 6 per cent or more, buying a farm on a deferred payment plan is a hopeless transaction, from the strictly business viewpoint. The results of this study have been published in Department Bulletin 874.

A similar study has been made in the bluegrass region of Kentucky, in cooperation with the Kentucky State College, and the results are now being tabulated.

A general bulletin on the farm-lease contract has been completed, and a study of the special problems of the rental contract in dairy regions is nearly completed. Considerable material has been accumulated on methods of renting land in regions of tobacco production and in cotton production regions. A study of methods of renting land in small-grain-producing regions is in progress, and an extensive study is being carried on in the relationship of landlord and tenant under the plantation system, with special reference to its bearing on plantation organization.

An extensive series of studies has been carried on during the year with respect to land settlement and colonization in the cut-over regions of the three Great Lake States—Minnesota, Wisconsin, and Michigan. These studies, carried on in cooperation with the Minnesota Experiment Station, the Wisconsin Experiment Station, and the University of Michigan, include investigation of the various settlement agencies with a view to determining the good and bad characteristics of the methods employed. Practically all the important

colonization and settlement companies operating in this region have been visited, and, in addition to this, typical settlement projects are being extensively studied.

In connection with a comprehensive study of land utilization in the Northern Great Plains, now being carried on as a department project, the Office of Farm Management and Farm Economics has assumed responsibility for the study of land tenure and of relationship of land tenure to range control and the utilization of farm land, and also the methods of settlement which have been and are now employed in the development of this region.

A special study of the relation of land tenure to range control and range utilization in Arizona and New Mexico has been completed in cooperation with the Forest Service.

In order to determine the degree to which the Federal Farm Loan System has promoted the acquisition of land by landless farmers, several thousand questionnaires were sent out, to which about 2,500 replies were received. The results of this investigation will soon be ready for publication.

#### FARM LIFE STUDIES.

During the year cooperative arrangements have been made between the rural life section of the Office of Farm Management and Farm Economics and various State colleges where instructors in rural sociology are employed.

Investigations in the social aspects of farm tenancy are perhaps the most important studies carried on by the section of farm life during the year. Seven States—Georgia, North Dakota, Missouri, South Carolina, Maryland, Iowa, and Nebraska—have cooperated in these studies. Twenty-five hundred farms and farm families in 20 different communities were intensively studied. It is expected that the results of this series of studies when tabulated will throw much new light on the whole subject of farm tenancy.

Studies in the social aspect of sales of farms have been carried on in five counties in Indiana. The number of sales in each county has been ascertained, the buyers and sellers located, the human side of the sale inquired into, and the human as well as the economic reasons for selling and buying brought out.

One farm community in each of three States—New York, Maryland, and West Virginia—has been studied, in cooperation with the colleges of agriculture. The type of study has been historical and analytical, covering a period of the last hundred years. The special questions at issue in this community analysis are the "migration of young people from the farms to the town and city"; the "influence of farm communities upon national life"; "the remedy for over-migration." The results of these studies will be published during the coming year.

The differences in social life in communities which are founded upon different types of agriculture are being studied in communities of the dairy, grain, and truck type of farming. Whether the people of different types of farming differ, and if so, in what respect they and their institutions differ, are the questions at issue.

Two State colleges—Wisconsin and New York—wish to analyze counties into primary population groups, in order to ascertain the



character of the inland "country community," and studies in this have been begun in cooperation with these institutions. These studies will open a new field in farm life research.

Many farm communities in the United States have built community houses within the last decade. A first-hand investigation of 250 of these community buildings has been made.

### AGRICULTURAL HISTORY AND GEOGRAPHY.

The research in agricultural history during the year has been devoted mostly to the early development of the sheep, wheat, and cattle industries in the United States; and more recently to the development of agriculture in the Northern Great Plains. Several maps showing shifts in agricultural industries in the United States from 1840 to 1910 have been made. A series of maps showing shifts in the population in the United States from 1790 to 1920 is being prepared, and other materials of historical value on this and other historical subjects are being accumulated for publication when the researches on the several subjects are completed.

Research on the agricultural resources of South America is in progress, and maps have been made showing the distribution of cattle, sheep, and swine. Similar maps of crop production are also being prepared. The relation of crop production and the distribution of live stock to climatic conditions is being studied and texts are being prepared to accompany the maps.

A geographical study of farm practices in growing wheat was published in the 1919 Yearbook and a similar but more thorough study of practices in growing cotton is now in progress. The completion of this work will wait upon the tabulation and use of the data of the 1920 Agricultural Census. Geographical studies of types of farming and live-stock practices are also in progress.

This section is also cooperating in the survey of the agricultural resources of the Northern Great Plains.

### FARM FINANCIAL RELATIONS.

The draft of a suggested model State law providing for the organization and regulation of farmers' mutual fire insurance companies was completed during the year, as was also the work on a suggested system of records for farmers' mutual fire insurance companies. Statistics were tabulated on farmers' mutual fire insurance companies with a view to securing comprehensive and reliable data concerning cost of insurance in these organizations.

Information on hail insurance in the United States has received special attention during the year, and a manuscript for a proposed bulletin, "Hail insurance on farm crops in the United States," containing historical as well as statistical and legal data on this subject, has been prepared for publication.

The data on rural credits and on rural telephones, both subjects transferred from the Rural Organization Project, formerly a part of the Bureau of Markets, have been supplemented to a limited extent during the year.



### EXTENSION WORK—SOUTH.

Cooperative work in farm management and farm economics in the Southern States has been continued as heretofore. The work has been conducted quite largely through the use of the Farm Account Book, supplemented by surveys, lectures, correspondence, newspaper articles, bulletins, and circular letters. The readjustment of the project, with a view to aiding the several States in establishing farm-management departments, increasing the amount of research work done, and making a more equitable division of the expense of conducting cooperative work, is now under consideration by the cooperating parties.

The College of Agriculture of Arkansas has established a department of farm management and farm economics, with A. D. McNair, of the Federal Office of Farm Management and Farm Economics, in charge on a cooperative basis. Similar arrangements were made with Mississippi, with R. W. Clothier representing the Office of Farm Management and Farm Economics in that State. Since Mr. Clothier resigned in April, 1920, to become president of the New Mexico Agricultural College this place has been vacant.

Cooperative adjustments have been made with Alabama and Georgia, and negotiations are being made with North Carolina for cooperation on a 50-50 basis. A cooperative-research project has been submitted to Virginia, but no action has been taken on it as yet.

### EXTENSION WORK—NORTH AND WEST.

Farm management demonstration work in the Northern and Western States is under the administration of the States Relations Service, with the Agricultural Economist in charge located in the Office of Farm Management and Farm Economics to facilitate closer cooperation. A special effort is being put forth to prepare the investigational data of the Office of Farm Management and Farm Economics in such form that the farm-management demonstrators, located in the several States, will be able to use the material advantageously in their work with the farmers.

While the work was devoted primarily to increased food production during the war, the program for 1919 was planned to meet the demand for information on more efficient farm operation. In order to accomplish this object more emphasis has been placed on training the county agents and other agencies in bringing to farmers in terms of their own farm business the principles of efficient farm organization and management. The method employed in bringing the information to farmers, in the main, has been to get them together in groups for instruction in recording, summarizing, and analyzing farm business records through the use of the farm account books prepared by the demonstrators. As many as 50,000 of these books have been put in the hands of farmers in a single State through the aid of county agents and bankers. Bankers have cooperated heartily in the work, distributing the larger portion of the books, the expense of which they have met as a service to their patrons.

The change from individual to group work has put the project on a basis that offers thorough instruction but will reach the number of

farmers required of a successful county, State, or national project. Even though this program has not been put in full operation in some States, the demonstrators in the 26 States cooperating have worked with over 52,000 farmers in groups, besides the individual service they have rendered, and the county agents and others have carried the same work to a much greater number. Other important lines of work include cost accounts on separate farm enterprises, fair exhibits, and tenancy contracts.

It is believed that the value of this work has been demonstrated and that the development of better methods of extension teaching is enabling the staff to carry the work to a much greater number of farmers. The interest manifested by banks and other institutions promises much toward the future success of the work. Also the change in general economic conditions brought about by the war has aroused the farmers' interest in better methods of farm organization and production. This, together with the necessity for farm accounts due to the income-tax law, is making farm-management work one of the most important extension projects.





## REPORT OF THE SOLICITOR.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
OFFICE OF SOLICITOR,

*Washington, D. C., September 29, 1920.*

SIR: I submit herewith report of the work of the office of the Solicitor for the fiscal year ended June 30, 1920.

Respectfully,

R. W. WILLIAMS, *Solicitor.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### SUMMARY.

The present Solicitor was promoted by you on April 1, 1920, to succeed William M. Williams, who was on that date appointed Commissioner of Internal Revenue.

Shortly before the resignation of the former Solicitor this office lost by transfer to other bureaus two of its ablest lawyers. One had served in the legal work of the department for many years and was in charge of a large and important section of the office. The other had not been so long in the legal work of the department, but by close study, application, and ability had acquired thorough familiarity with the complex legal and administrative questions involved in several lines of the department's activities. The resignation of the former Solicitor and the transfers of the lawyers referred to made it necessary for the present Solicitor, at the outset, to reorganize the office on a basis adequate to continue the orderly and expeditious performance of the legal work of the department. This reorganization was speedily accomplished, though not without much difficulty, and it is pleasing to report that the legal work of the department has proceeded with the customary dispatch and efficiency. Other resignations and transfers during the year have deprived the office of several of its most efficient and industrious lawyers, necessitating the bringing in of successors who were unfamiliar with the work of the department and who, obviously, must spend some time in training before they can attain that degree of efficiency which is required for satisfactory service in this office.

Notwithstanding the adverse circumstances under which the office was compelled to operate during the year, as above indicated, a largely increased volume of business over previous years was handled. The present Solicitor wishes to take this opportunity to express his grateful appreciation of the loyal and splendid cooperation given him by his assistants, both professional and clerical, in the conduct of the legal work of the department since he became Solicitor.

There were seven resignations from the legal staff of the office during the year and three since its close. With one exception these men received and accepted from other bureaus in this department or from other departments offers of salary considerably larger than they were receiving in this office. The exception was an assistant who resigned to reenter private practice in St. Louis. Manifestly, the legal work of the department can not be maintained at the highest point of efficiency with so many resignations and transfers in so short a period. This situation threatens to be repeated in the ensuing year.

The work of the office increased substantially during the year, owing in part to the expanding activities of the department under recently enacted statutes, such as the migratory bird treaty act, but largely to the increasing frequency with which the United States attorneys call upon the office for assistance in the preparation of the department's cases for trial in the courts and for assistance in the trials. More cases were reported to the Department of Justice (7,353), more written opinions rendered (827), and more legal papers prepared (3,298) than in the previous year.

In order to conserve the time of the United States attorneys and to expedite litigation under the 28-hour law, this office, shortly before the close of the year, undertook and has continued the preparation of the complaints or declarations to be filed in the courts in these cases. The plan has worked well and is in line with the practice of the office for several years past in reporting criminal cases to the Department of Justice in the form of prepared informations or indictments.

The regulatory work of the department was increased during the year by acts of Congress transferring to the Secretary of Agriculture all the powers and duties theretofore vested in the Secretary of the Treasury by the tea importation act of March 2, 1897, and all the powers and duties theretofore conferred upon and exercised by the Secretary of Commerce with reference to land fur-bearing animals in Alaska. Important amendments of acts of Congress were also made, resulting in an extension of the department's activities, such as the amendment of the Bureau of Animal Industry act of May 29, 1884, permitting the interstate movement of domestic animals reacting to the tuberculin test; the amendment of the food and drugs act of June 30, 1906, extending the net weight amendment of March 3, 1913, to wrapped meats inclosed in papers or other materials as prepared by the manufacturer thereof for sale; and the amendment of the plant quarantine act providing a comprehensive system for the control of insect pests and plant diseases in the District of Columbia.

Some of the activities of the department relating directly to the war were continued during the fiscal year. In furtherance of this work assistance was given the Bureau of Markets in closing its accounts in connection with the allotment and sale of nitrate of soda to farmers for the crop season of 1919, including certain large shortages appearing in the accounts of one of the port distributors and certain large demurrage claims against vessels carrying nitrate of soda. Many nitrate shortage claims were reviewed to determine the liability of the Government therefor. Conferences were held with the Bureau of Markets and representatives of fertilizer importers and dealers relative to the fertilizer shortage for the 1920 crop season, which resulted in the passage of a resolution by Congress (Pub. Res. No. 39, 66th Cong.) authorizing the Secretary of

War to turn over to agricultural fertilizer distributors or users a supply of nitrate of soda. Assistance was given in hearings and conferences and in the drafting of correspondence with fertilizer manufacturers. Representatives of the office conducted various hearings throughout the country and otherwise assisted in the proceedings relating to live-stock commission and yardage rates and other charges for service at stockyards. Consideration was given to complaints submitted against members of the Chicago Live Stock Exchange, and against live-stock commission companies for overcharges in feed accounts. Action by the department on such complaints and hearings resulted in several suits in Federal courts to enjoin the Secretary of Agriculture from revoking licenses for failure of the licensees when ordered by the department to distribute to the shippers sums of money ascertained by the department to be in excess of amounts to which such licensees were entitled. This office spent considerable time and effort in preparation for and in participation in the trial of these cases. Six indictments under the Lever Food Control Act were also prepared and transmitted to the Attorney General with the recommendation that criminal proceedings be instituted. Much time and effort were spent in conferences and correspondence with members of the Bureau of Markets and with representatives of the wool trade relative to the payment by wool dealers to the Bureau of Markets, under regulations promulgated by the War Industries Board, of certain excess wool profits made by them on the 1918 wool clip. Assistance was also given in the preparation of regulations to carry into effect the food products inspection law and in the preparation of a bulletin under that law and the regulations.

Under the Saulsbury resolution and the Ball amendment to the antiprofitereing law, effective in the District of Columbia, the office advised and handled in court the cases of a number of department employees threatened with eviction from their rented premises.

Under your direction and pursuant to requests of committees or Members of Congress, this office prepared or assisted in the preparation of several bills or revisions of bills of a comprehensive nature for regulating cold storage of food products (H. R. 9521, 66th Cong., and S. 3868, 66th Cong.), together with a compilation of State laws relating to cold storage of articles of food (Part IX, Appendix I, of hearings before the House Committee on Agriculture, Aug. 11, 1919); and for standardization of hampers and round-stave baskets (H. R. 12350, 66th Cong.).

Lawyers of the office also appeared before committees of Congress and conferred with members thereof, and the office made written comments relative to provisions of the various bills to regulate the packing industry (including S. 2199, 66th Cong.; S. 2202, 66th Cong.; and H. R. 5310, 66th Cong.). Consideration was given to the matter of regulating dockage of live stock. A bill to provide for State farmers' mutual insurance was revised and amended and a proposed grain grading and inspection law of Oregon was considered and comments made thereon. Amendments to the North Carolina State warehouse act were prepared, after conferences with the officials of the State and representatives of the Bureau of Markets, and a bill to be introduced in certain State legislatures providing for cooperation on the part of the States with the Biological Survey in the



extermination of predatory animals and rodents was also reviewed and revised. Proposed bills amending highway statutes of several States were reviewed to determine whether they met the requirements of the Federal aid road act. There was also drafted a bill authorizing the Secretary of War to transfer certain surplus motor-propelled vehicles and motor equipment and road-making material to the various services and departments of the Government, and for the use of the States, which became a law on March 15, 1920. Numerous special items included in the Agricultural appropriation bill were drafted and reviewed, including an amendment of the plant quarantine law to regulate movement of nursery stock and other plants and plant products into the District of Columbia; a provision for eradication of tuberculosis in animals and authorizing the Secretary of Agriculture to pay part of the value of the animals destroyed in cooperation with the States in the eradication of tuberculosis; amendment of the food and drugs act with reference to foods in package form; amendment of the act of May 29, 1884, providing for the regulation of interstate transportation of animals reacting to the tuberculin test; a provision declaring certain amendments of the cotton futures act to be permanent legislation; and an item authorizing the acquisition by the Government by gift, devise, or purchase of certain tracts of land occupied by the Bureau of Plant Industry as experiment stations.

A considerable part of the time of the office was consumed in appearance of its members before committees of Congress in hearings held on various bills affecting in whole or in part the work of the department.

The office prepared or assisted in the preparation of the department's reports upon various bills referred to it by committees of Congress having them in charge. Among the bills reported upon were 33 affecting the national forests, one authorizing associations of producers of agricultural products, another relating to rural credits, one dealing with the establishment of weights and measures for wheat and corn mill products, one providing for the addition of lands to the Fremont National Forest found to be chiefly valuable for stream flow and the protection of timber and improvement of grazing, another authorizing the exchange of lands within the Rainier Forest, and one providing for the consolidation of lands in the national forests of South Dakota. In response to requests, members of this office frequently participated in hearings and conferences in Washington and elsewhere touching the various activities of the department. Among the hearings held were 17 in connection with the supervision of stockyards under the President's proclamations of June 18 and September 6, 1918; 16 in market centers relative to the regulation of grain warehouses; 10 in market centers on the regulation of wool warehouses, and 7 in market centers on rice standards; also 2 hearings with respect to alleged violations of the grain standards act, and several dealing with the settlement of cases under the 28-hour law. Conferences were attended relative to the amendment of the rules of future exchanges to conform to the cotton futures act, as amended; to classification of cotton and the establishment by the Bureau of Markets of spot cotton quotation service; to disputes between buyer and seller under the cotton futures act; to general revision of the grain standard regulations; to revision of the official

wheat standards; to the preparation of plans for cooperative administration of wheat grades in Kansas, Oklahoma, and other States, and to the powers, duties, and work of the United States game wardens.

The office prepared, or assisted in the preparation of, numerous regulations, orders, forms, specifications, and schedules required in the administration of various statutes committed to the department for execution. Some of the more important of these were regulations governing the importation of animals; amendment of the meat-inspection regulations and of regulations under the migratory bird treaty act and under the Alaska game law; regulations under the virus, serum, and toxin law; regulations governing interstate movement of live stock; regulations governing compensation to the owners of tuberculous cattle destroyed; regulations to carry into effect the food-products inspection law; regulations governing wool and grain warehouses; regulations under the plant quarantine act; amendments of regulations under the cotton futures and grain warehouse acts; and numerous amendments of the administrative and fiscal regulations. Orders for the establishment of plant and animal quarantines and for the revocation and suspension of licenses of grain inspectors were prepared. Assistance was given in the preparation of specifications of commercial grades of a number of vegetable products and in the preparation of grain-inspection certificates and appeal forms under the grain-standards act.

The long and stubborn contest against enforcement of Federal legislation for conservation of migratory birds was brought to a close on April 19, 1920, when the Supreme Court of the United States in the case of the State of Missouri *v.* Ray P. Holland, United States game warden, sustained the constitutionality of the treaty with Great Britain for the protection of migratory birds and the act of Congress of July 3, 1918, to carry the treaty into effect. This case was an appeal by the State from the decision of the district judge for the western district of Missouri dismissing the State's suit to enjoin the United States game warden from enforcing the migratory bird treaty act in Missouri (258 Fed., 479). The importance of the migratory bird treaty and the act of Congress to carry it into effect is emphasized by the Supreme Court in its reference to the subject matter of the treaty and the act as "a national interest of very nearly the first magnitude."

Law work for the Forest Service during the year, other than under the Weeks Forestry Law, included handling the following cases and other business:

*Law work for the Forest Service.*

Claims to lands.....	475	Trespasses:	
Hearings attended.....	44	Grazing.....	502
Depositions taken.....	9	Timber.....	37
Briefs prepared and filed.....	21	Fire <sup>1</sup> .....	96
Appeals to Secretary and brief.....	5	Occupancy.....	22
Motions for rehearing and brief.....	1	Property.....	7
Petitions for exercise of supervisory authority.....	1	Game.....	7
Oral arguments.....	2	General litigation.....	24
		Contracts, leases, and similar papers.....	1,427
		Written opinions.....	383

<sup>1</sup> 190 cases prosecuted in State courts in addition to the number above reported.

The following is a summary of the work of the office in connection with the acquisition of lands under the Weeks Forestry Law:

*Acquisition of lands under Weeks forestry law.*

Character of work.	Tracts.	Acreage.
Purchases authorized by National Forest Reservation Commission.....	230	101,587.00
Agreements of purchase prepared.....	242	138,418.00
Titles in process of examination at beginning of year.....	53	138,725.00
Examinations of title completed and reported to Department of Justice:		
Purchases recommended.....	164	71,052.00
Condemnations recommended.....	58	63,169.35
Titles approved by Attorney General and in process of adjustment.....	19	25,762.00
Titles in process of examination at end of year.....	37	73,205.00
Completion of direct purchase after approval of titles by Attorney General.....	168	75,792.96
Completion of purchases of lands acquired by condemnation.....	56	41,667.68

Two meetings of the National Forestry Reservation Commission were attended.

The following table shows the number of contracts and leases prepared or examined for sufficiency and proper execution for the various bureaus, divisions, and offices of the department:

*Contracts and leases prepared or examined.*

Bureau, division, or office.	Contracts.	Leases.	Bureau, division, or office. <sup>1</sup>	Contracts.	Leases.
Forest Service.....	1,439	.....	Bureau of Markets.....	5	30
Bureau of Animal Industry.....	10	26	Mechanical Shops.....	1	.....
Biological Survey.....	.....	6	Bureau of Plant Industry.....	16	43
Bureau of Chemistry.....	7	7	Bureau of Public Roads.....	1,561	21
Chief clerk.....	8	7	Division of Publications.....	1	.....
Bureau of Crop Estimates.....	5	4	Supply Division.....	3	.....
Bureau of Entomology.....	8	37	Weather Bureau.....	10	27
Office of Exhibits.....	.....	1	Farm Management.....	1	.....
Federal Horticultural Board.....	5	6			
Insecticide and Fungicide Board.....	1	2	Total.....	3,081	217

During the fiscal year 58 bonds, 318 renewals, and 34 terminations of leases and contracts were prepared.

Eight hundred and twenty-seven formal opinions, including the 383 above mentioned for the Forest Service, were rendered to officials, bureaus, divisions, and officers of the department. Numerous letters and service and regulatory announcements of the several bureaus of the department, containing instructions, information, and opinions with reference to the statutes administered by them, were also examined and modified or reformed when necessary. In addition, many requests of the various bureaus for opinions were answered by brief written notations on papers containing the request, thus saving time and expediting the answer. Frequently administrative officers of the department were advised in reference to their work in oral conferences, of which no record was made. Suggestions with reference to pleadings in approximately 200 food and drugs cases were made for the assistance of United States attorneys, and there were prepared in a number of cases, at the request of United States attorneys, forms of decrees for entry therein by the courts.



Twenty-two applications for letters patent on inventions of employees of the department for dedication to the public were prepared and filed. Of the applications pending at the close of the last fiscal year and of those filed during this fiscal year, 17 were allowed. Interferences were declared by the Patent Office in five cases between the applications for letters patent by employees of this department and applications filed by outside parties. Two of these cases, one involving a novel septum for a honeycomb and the other a chemical process, terminated favorably to the department employees. The other three cases are still pending.

Project statements for 1,718 projects under the Federal aid road act, of which 1,717 were approved, involving a total estimated expenditure of \$251,083,518.86 and 16,529 miles of road, were reviewed, and 1,287 project agreements under that act, with certificates of approval of plans, specifications, and estimates, involving a total estimated expenditure of \$197,623,054.06, were examined. There were also examined 263 drafts of modifications of agreement and certificates prepared by the Bureau of Public Roads and 50 original and 16 supplemental cooperative agreements under section 8 of the act relating to roads and trails in national forests.

Thirty-seven claims for balances due estates of employees of the department, who died intestate, were examined, the necessary papers prepared for their payment, and advice furnished administrative officers of the department relative to the same.

Ten miscellaneous cases involving violations of laws other than regulatory statutes, or relating to the miscellaneous work of the department, received consideration by this office and were referred to the Department of Justice for appropriate action. In addition, one case involving misconduct of an employee was reviewed and necessary investigation made and appropriate papers prepared. Advice was also given on the special features of several other personnel cases.

Aid was given the advisory committee on finance and business methods in drafting orders and memoranda of the Secretary for the general administration of the department, and to the Office of Inspection in the consideration of a number of claims for reimbursement for property lost or destroyed while being used for official work in the national forests.

Many service and regulatory announcements, circulars, and bulletins, referred to this office by the Division of Publications for examination as to possible legal questions involved, were reviewed, and numerous letters for the Secretary's signature, prepared in the various bureaus, offices, and divisions, were referred to this office for comment prior to signature.

Many documents of various kinds, including statements of issues, briefs, and memoranda on legal matters, were prepared on behalf of the officials of this department for submission to the Attorney General, the Secretary of the Interior, the Comptroller of the Treasury, and the officials of other departments.

Testimony adduced at hearings held on charges preferred against serum companies for violations of the regulations governing the preparation, shipment, and importation of viruses, serums, toxins, and analogous products intended for use in the treatment of domestic animals was reviewed and the Secretary and the Bureau of Animal

Industry advised with reference to the proper action to take on the charges.

Seven thousand three hundred and fifty-three violations of statutes entrusted to the department for enforcement were reported, 5,555 to the Attorney General and 1,798 to the Director General of Railroads, pursuant to the agreement between the Attorney General, the Director General, and this department, for report to the Director General of violations of the 28-hour law occurring after the Government assumed control of the railroads. The following table shows the several statutes under which these violations were reported and the amounts of fines and recoveries in cases settled with and without litigation.

*Violations of statutes considered.*

Law invoked.	Violations.	Fines and recoveries.
Laws for the protection of national forests.....	688	\$90,308.36
Food and drugs act.....	2,572	24,453.41
28-hour law.....	3,257	67,700.00
Animal quarantine acts.....	30	6,275.00
Meat inspection act.....	35	455.00
Lacey Act.....	28	1,070.00
Bird reservation trespass law.....	3	35.00
Migratory bird treaty act.....	545	8,976.00
Game violations occurring in—		
National forests.....	13	120.00
Pisgah Game Preserve.....	4	20.00
Virus act.....	1	1,510.00
Insecticide act.....	151	3,436.00
Plant quarantine act.....	9	90.00
United States grain standards act.....	4	300.00
Miscellaneous.....	10	.....
Total.....	7,353	204,788.77

Under authority of section 4 of the food and drugs act and section 4 of the insecticide act 1,430 notices of judgment were prepared for publication. In addition to the criminal prosecutions above tabulated, 1,456 decrees of condemnation and forfeiture were entered under the food and drugs act and 19 under the insecticide act.

Consideration was also given to many cases that were not reported to the Department of Justice because of the absence of proof or material facts.

Many memoranda and briefs on legal questions were furnished on cases reported to the Department of Justice for prosecution, and in some assistance was given in taking depositions and statements of witnesses and in the trials. Among the important cases in which this office assisted, either in the preparation of briefs or in the trials, or both, were *United States v. Northern Pacific Railroad Co.*, *United States v. Kern River Co.*, *United States v. South River Lumber Co.*, *United States v. Cowart*, and *United States v. George D. Moore and Whiting Manufacturing Co.*, *United States v. Raine-Andrews Lumber Co.*, all involving alleged rights to lands or the use of lands in the National Forests; *United States v. Monsanto Chemical Co.*, *United States v. Newton Tea and Spice Co.*, *United States v. 4 Dozen Bottles Pildores Urisepticas*, *United States v. 2,967 Cases Tomatoes*, *United States v. 50 Barrels Vinegar*, *United States v. Gingerole Co.*, *United States v. Kar-ru Chemical Co.*, *United States v. 141 Bottles Texas Wonder*, *United States v. St. Louis Dairy Co.*, and *United*

States *v.* Albert C. Krumm, all involving violations of the food and drugs act; Kuenster Live Stock Commisison Co. *v.* Meredith, a suit to restrain the Secretary of Agriculture from revoking the company's license under the Lever law for failure to return to shippers of live stock sums of money found to be due them on account of certain charges for feed; United States *v.* Rockefeller, involving violation of the migratory bird treaty act; and United States *v.* Parke, Davis & Co., involving a violation of the insecticide act.

In addition to the opinions expressed in letters and memoranda to the various officials, bureaus, offices, and divisions of the department, frequent daily conferences were had with them with reference to legal questions involving their work. The work of the office considering its nature was current at the end of the year.

A more detailed statement of the work of the office during the year, without reiteration of what has been fairly covered by the foregoing summary, follows.

## THE NATIONAL FORESTS.

### LAND CLAIMS.

At the commencement of the fiscal year there were pending 344 cases. During the year there were added 108 cases, and 130 were closed, leaving 322 pending. A total of 452 were handled, involving land claimed under the homestead, timber and stone, mineral, railroad, lieu selection, and other general and special laws.

One hundred and eleven decisions were rendered, including those of the registers and receivers and the Commissioner of the General Land Office, subject to review, respectively, by the Commissioner of the General Land Office and the Secretary of the Interior. The registers and receivers decided 13 for and 17 against the United States; the commissioner 31 for and 29 against the United States; and the Secretary 4 for and 17 against the United States.

Of the 130 cases closed during the year, 27 were by decisions in favor of the Government and 35 by decisions for claimants. In 21 cases the claims were canceled or relinquished. In 40 the Forest Service protest was withdrawn (in nearly all of the cases the commissioner or the Secretary reduced the required amount of cultivation to that shown by the entryman), and in 7 cases the proof was withdrawn after protest. As a result of the 27 decisions in favor of the Government, approximately 4,320 acres of land, supporting a stand of 22,235,000 feet of timber, valued at approximately \$88,840, were saved to the Government.

The remaining 322 cases received attention varying in degree with their progress in the Forest Service and in the Department of the Interior. Hearings were attended in 44 cases. Depositions were taken in 9 cases. Briefs were filed in 21 cases. Two cases were orally argued before the Secretary of the Interior and one motion for rehearing, supported by brief, was filed. One appeal to the Secretary of the Interior, accompanied by brief, was prosecuted and one petition for the exercise of supervisory authority, accompanied by brief, was made to the Secretary.

The assistants to the Solicitor in the field examined and passed upon the evidence in many cases in addition to the 108 new cases in which protests were prepared to be filed in the local land offices by the



district foresters, and either returned the papers for additional evidence or recommended that no objection be made to the issuance of patent.

#### TRESPASS.

Damages and fines recovered during the year for trespass on the national forests were:

#### *Penalties for trespass on national forests.*

Class of trespass.	Damages.	Fines and recoveries.
Grazing.....	\$50,163.25	\$885.30
Timber.....	13,181.74	
Fire.....	19,659.67	2,092.67
Property.....	93.00	
Game.....		120.00
Miscellaneous <sup>1</sup> .....	3,984.73	128.00
Total.....	87,082.39	3,225.97

<sup>1</sup> This includes 7 criminal cases where defendant had agreed to fight fire but after having been furnished with railroad transportation failed to do so. In addition, sentences of 75 days in jail were imposed.

#### COURT DECISIONS OF INTEREST INVOLVING NATIONAL FORESTS.

The county attorney of Coconino County, Ariz., filed a complaint charging the forest supervisor with a violation of a State statute which requires all railroad companies that fence their rights of way to leave crossings open and accessible for stock at least every 3 miles. The forest supervisor, in obedience to instructions, closed the crossing left open by the Atchison, Topeka & Santa Fe Railroad in their right of way fences through the forest. The supervisor was arrested and thereafter application was made to the Federal district court for a writ of habeas corpus. The writ was granted and the supervisor discharged.

In *Byron v. United States* (259 Fed., 371) the Circuit Court of Appeals for the Ninth Circuit held that, under the act of June 25, 1910 (36 Stat., 847), the President is authorized to withdraw public lands temporarily, pending legislation by Congress looking to their inclusion within a national forest, and that immediately upon cancellation of patent for lands within a national forest the lands become a part of the forest. This decision operates on lands in the State of Oregon, which is one of the States in which a national forest can not be created or enlarged except by act of Congress.

The case of *Rolfs and Jessen v. E. T. Chapin Co., United States intervenor*, involves the right of the Forest Service to sell fire-killed timber from an unperfected mining claim. A contract was made between the Forest Service and the Chapin Co. to sell fire-killed timber from lands in the Coeur d'Alene National Forest, Idaho, which were found to be embraced within the boundaries of the unperfected mining claims of Rolfs and Jessen. Mining claimants sought an injunction. The United States intervened, to which action plaintiffs unsuccessfully demurred.

In *United States v. Northern Pacific Railway Co.* (264 Fed., 898) the Circuit Court of Appeals for the Ninth Circuit held that under the land grant to the Northern Pacific Railway Co. of July 2, 1864, on completion of the road the company became vested with a con-

tract right to select nonmineral lieu lands within the indemnity limits and the United States could not defeat such right by withdrawal of the lands, prior to survey and selection, for possible inclusion in a national reservation.

In *United States v. Kern River Co. et al* (264 Fed., 412), the Circuit Court of Appeals for the Ninth Circuit held that the act of March 3, 1891, limiting suits to vacate patents to public lands does not apply to a suit to set aside the approval by the Secretary of the Interior of a canal company's maps of location filed to obtain a right of way across public lands where such approval was secured by misrepresentations; that statutes of limitation do not run against the Government in the absence of express statutory provision; that, if the statute is applicable to a class of suits only, it will not be extended to other cases by implication; that the approval by the Secretary of the Interior of a canal company's maps of location filed as a basis of right of way through a forest reserve was obtained by fraud, where at the time of the original and amended application its attention was called to two statutes, one granting a right of way for irrigation and the other for development of power, but falsely certified that the right of way was desired solely for the purposes described in the act relating to rights of way for irrigation purposes; and that if the approval by the Secretary of the Interior of a canal company's maps of location of a right of way through a forest reserve was given with full knowledge of the fact that the canal was to be constructed for power purposes and that the company had not complied with the statute relative to rights of way for such purposes, he exceeded his authority, and the validity of his approval might be challenged in a suit to set aside such approval and restrain use of the right of way.

The case of *United States v. South River Lumber Co.* was a suit in equity in the western district of Virginia. One Guthrie had agreed to convey land to the Government under the act of March 1, 1911 (36 Stat., 961), known as the Weeks law, such conveyance to be in fee, subject only to certain mineral reservations. After the agreement for purchase had been executed by the vendor and the Secretary, the vendor granted the use of a right of way to the railroad company. After title vested in the Government, the company refused to remove its railroad from the land. By decree dated February 28, 1920, the company was enjoined from operating its railroad over the land or from attempting to use the right of way, and it was allowed 90 days within which to remove the railroad ties and railroad apparatus from the land. Thereafter the company applied for and received a permit for the right of way.

*United States v. Cowart* was a suit in equity to restrain the defendant from cutting timber on lands agreed to be sold to the Government under the act of March 1, 1911 (36 Stat., 961), commonly known as the Weeks forestry law. The vendor thereafter conveyed the lands to one Cowart, who began cutting timber thereon. Condemnation proceedings were instituted and the suit for injunction was filed to restrain the timber cutting. The court granted the injunction. The case is of interest in that an action by the Government was sustained prior to the acquisition of title by the United States, and while the Government was not in possession, in order that its rights initiated by the condemnation proceedings might be protected.

### IMPORTANT DECISION OF THE SECRETARY OF THE INTERIOR AFFECTING FOREST RESERVATIONS.

In the case of Helen G. Rankin (47 L. D., 329) it was held that while the act of June 4, 1897, provides that mineral lands in any forest reservation shall continue to be open to location and entry under the mining laws, yet this does not prevent their withdrawal and reservation from any and all forms of private appropriation for public use.

### WEEKS FORESTRY LAW.

(36 Stat., 961.)

As no additional appropriation was made by Congress for the extension of the work under the Weeks forestry law, work thereunder during the year was largely confined to purchases authorized by the National Forest Reservation Commission during the preceding year.

During the year the National Forest Reservation Commission authorized the purchase of 230 tracts, aggregating 101,587 acres. These tracts are comparatively small in area and are to be acquired for the purpose of blocking in units heretofore purchased and which are now under forest administration.

The number of title attorneys engaged in the examination of titles to land acquired under this law is being reduced, and unless further appropriations are made during the coming year it is anticipated that all examinations of titles of lands authorized to be acquired will have been completed by June 30, 1921.

The following is a summary, in terms of acres, of operations under the Weeks forestry law from the beginning to June 30, 1920:

*Operations under the Weeks forestry law from the beginning to June 30, 1920.*

State.	Area.	Purchases authorized (estimated).	Purchases completed (actual survey).	Reports in Department of Justice.	
				For opinion (actual survey).	For con- demnation (actual survey).
		<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Alabama.....	Alabama.....	62,966.00	31,520.55	7,847.00	7,557.83
Arkansas.....	Arkansas.....	19,802.84	8,285.27	1,963.00	
	Ozark.....	16,726.00	3,809.13	1,376.00	1,272.77
Georgia.....	Georgia.....	68,479.00	60,233.72	335.00	
	Savannah (S).....	85,186.00	47,511.29	604.00	27,325.53
Maine.....	White Mountain.....	32,153.00	27,859.78	1,100.00	1,477.42
New Hampshire.....	do.....	401,025.83	355,471.99		16,290.96
North Carolina.....	Boone.....	49,795.00	28,522.32		16,181.21
	Mount Mitchell.....	77,475.00	68,869.93	430.70	6,071.95
	Nantahala.....	73,367.00	35,752.26	29,335.36	
	Pisgah.....	88,216.00	80,094.41		8,860.65
	Savannah (N).....	37,933.00	36,502.91		493.35
South Carolina.....	Savannah (S).....	18,612.00	18,454.26		
Tennessee.....	Cherokee.....	141,435.00	113,723.71	1,032.00	21,858.17
	Smoky Mountain.....				
	White Top.....	47,168.00	47,112.63		
	Unaka.....	58,072.00	39,944.90	2,622.36	5,070.36
Virginia.....	Massanutten.....	57,502.00	50,918.89		6,401.47
	Natural Bridge.....	116,109.50	87,166.74	3,870.00	1,925.54
	Potomac.....	41,307.00	30,635.03		3,604.08
	White Top.....	23,296.00	20,096.63		307.68
West Virginia.....	Shenandoah.....	149,674.03	141,288.90		193.88
	Monongahela.....	78,728.00	53,335.47		
	Potomac.....	38,360.00	31,873.54	320.00	1,889.94
	Shenandoah.....	13,400.00	13,318.45		
Total.....		1,796,788.20	1,430,302.71	50,835.42	126,782.79



**PLANT QUARANTINE ACT.**

(37 Stat., 315.)

Nine cases were reported to the Attorney General, all under section 8 (domestic quarantines) of the act as amended by the act of March 4, 1917 (39 Stat., 1134, 1165).

At the close of the fiscal year 1919 there were 15 cases pending. One case was closed prior to the beginning of the year 1920, but not reported until too late to include it in the annual report for the previous year. Of the 24 cases pending, 9 were closed during the year, 6 by fines amounting, collectively, to \$90 and \$20.95 costs, and 3 were dismissed.

Fourteen cases are now pending.

A number of proposed orders of the Secretary of Agriculture to establish, and of regulations to enforce, quarantines under the law were examined as to their legal form and sufficiency.

**FEDERAL AID ROAD ACT.**

(39 Stat., 355.)

Project statements for 1,718 projects were reviewed during the year to determine whether the projects were eligible for Federal aid under the provisions of the act. Of these, 1,717 were approved and 1 was disapproved. The 1,717 projects which were approved involved a total estimated expenditure of \$251,083,518.86, Federal aid in the amount of \$109,077,546.12, and 16,529 miles of road.

During the fiscal year project agreements and certificates of approval of plans, specifications, and estimates, prepared by the Bureau of Public Roads, for 1,219 projects were reviewed as to their legal form and sufficiency before being transmitted to the State highway departments for execution. Of the project agreements and certificates so examined during the fiscal year, together with a number of those so examined during the previous fiscal year, 1,287 were subsequently examined as to the sufficiency of their execution by the State highway departments and were submitted to the Secretary and executed by him. The agreements so executed involve a total estimated expenditure of \$197,623,054.06, Federal aid aggregating \$85,945,432.71, and 9,402 miles of road.

Drafts of modifications of agreements and certificates, prepared by the Bureau of Public Roads, were similarly reviewed in 263 cases. Of the drafts of modifications of agreements and certificates so reviewed, together with a number which were similarly reviewed during the previous fiscal year, 266 were subsequently examined as to whether they were properly executed by the State highway departments and were submitted to and executed by the Secretary.

Statutes of five States amending former highway statutes were reviewed to determine whether they met the requirements of the Federal aid road act.

Proposed standard plans, specifications, and notice to bidders, and contract and bond forms for use in carrying out the cooperation contemplated and authorized by the act, which were submitted for consideration by the State highway departments of six States, were reviewed as to their legal form and sufficiency.

Opinions were rendered on a number of important questions arising under the act. In addition to the above list, 50 original agreements and 16 supplemental agreements for the construction of forest road projects were reviewed as to form and substance.

#### IMPORTANT OPINIONS INVOLVING THE ADMINISTRATION OF THE FEDERAL AID ROAD ACT.

The Attorney General on September 27, 1919, in response to the request of this department, rendered an opinion holding that section 5 of the act of July 19, 1919 (41 Stat., 163, 233), authorizing the Secretary of War to transfer to any other branch of the Government having an available appropriation, at a reasonable price not to exceed cost, any surplus motor-propelled vehicles and motor equipment of any kind, did not operate to repeal section 7 of the act of February 28, 1919 (40 Stat., 1189, 1201), giving authority to the Secretary of War to transfer to the Secretary of Agriculture all available war material, equipment, and supplies not needed for the purposes of the War Department, but suitable for use in the improvement of highways, for distribution among the several State highway departments. The War Department upon the advice of the Judge Advocate General of the Army had taken the position that there was an implied repeal. The Attorney General sustained the opinion of this office on the question.

In an opinion of April 1, 1920, the Comptroller of the Treasury held that the appropriation made by the Federal aid road act for the construction of rural post roads was not available for the construction of a bridge between Portsmouth, N. H., and Kittery, Me., for which an appropriation had been made in the naval appropriation act of July 11, 1919 (41 Stat., 143). The latter appropriation was held to be exclusive of the use of any other general appropriation to increase the Government's contribution toward the expense of the bridge.

In an unpublished opinion of April 14, 1920, the Comptroller of the Treasury held that the appropriation made by section 8 of the act of February 28, 1919 (40 Stat., 1200, 1201), is available for the construction of temporary storage buildings in which to store the surplus war material, equipment, and supplies transferred to the department under the authority of section 7 of the above-mentioned statute and the act of March 15, 1920 (41 Stat., 530), for use in the survey, construction, and maintenance of forest roads and trails.

#### THE FOOD AND DRUGS ACT.

(34 Stat., 768.)

Twenty-one hundred and sixty-eight cases were transmitted to the Department of Justice, in 426 of which criminal proceedings and in 1,742 of which seizures were recommended. The 426 criminal cases embraced 830 alleged violations of the food and drugs act.

At the close of the fiscal year 1919, 967 cases were pending, of which 330 were criminal prosecutions and 637 were seizures.

Seven hundred and thirty-eight cases pending at the close of the fiscal year 1919 and 1,268 reported during the fiscal year 1920, in all 2,006, were terminated in 1920. Of those terminated, 462 were criminal and 1,544 were civil.

In 422 of the 462 criminal cases fines were imposed or collateral forfeited. In 409 of these cases pleas of guilty, nolo contendere, etc., were entered, in 5 of them fines were imposed after trial and conviction, and in 8 collateral that had been deposited by defendants was forfeited by reason of their nonappearance in court. In 1 the judgment of conviction in the lower court was affirmed by the Circuit Court of Appeals, 32 were nolle prossed or the information dismissed, and 7 were withdrawn.

In the criminal cases in which convictions were obtained the fines were as follows:

*Fines assessed under food and drugs act in cases reported by this department to the Department of Justice.*

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
1	\$0.01	\$0.01	58	\$100.00	\$5,800.00
1	1.00	1.00	1	120.00	120.00
14	5.00	70.00	1	125.00	125.00
58	10.00	580.00	5	150.00	750.00
6	15.00	90.00	1	168.40	168.40
18	20.00	360.00	2	175.00	350.00
1	21.00	21.00	12	200.00	2,400.00
116	25.00	2,900.00	2	225.00	450.00
11	30.00	330.00	3	250.00	750.00
1	38.00	38.00	7	300.00	2,100.00
5	40.00	200.00	1	275.00	275.00
75	50.00	3,750.00	1	340.00	340.00
5	60.00	300.00	1	500.00	500.00
2	70.00	140.00	1	600.00	600.00
9	75.00	675.00			
3	90.00	270.00	422	.....	24,453.41

In addition to the fines imposed costs were generally assessed.

Of the 1,544 civil cases terminated during the year, decrees of condemnation and forfeiture or informal orders for the disposition of the property were entered in 1,456, in 24 the libels were dismissed, in 54 the packages were broken or disposed of before seizure could be made, in 8 the libels were withdrawn, and in 2 verdicts were returned for the claimant after trial. In addition the Circuit Court of Appeals for the Fifth Circuit affirmed the judgment of the trial court in a case in which the condemnation of the article proceeded against was decreed. In the 1,456 cases in which decrees of condemnation and forfeiture were entered, the goods were destroyed in 997, released on bond or otherwise in 391, and sold in 68. In many of the cases in which the product was ordered released or sold the decree of the court provided that the product should be sorted and that portion found unfit for food should be destroyed.

At the close of the year 1,129 cases were pending, of which 294 were criminal prosecutions and 835 were seizures.

In addition to the cases reported by this department to the Department of Justice, the food and drugs officials of the various States and the District of Columbia, collaborating with the department in the enforcement of the act, are shown by the records of this office to have reported 65 cases to the United States attorneys, which were terminated during the year. Of these, 64 were criminal cases and 1 was a seizure proceeding.

In 63 of the criminal cases there were pleas of guilty or nolo contendere, or the collateral deposited by defendants was forfeited on



account of nonappearance. Fine was imposed in one criminal case after the trial and conviction of the defendant. In the seizure proceeding a decree of condemnation was entered and the product was released on bond. The fines or amounts forfeited as collateral in criminal cases were as follows:

*Fines in food and drug cases begun by United States attorneys.*

Number of cases.	Amount of fines or collateral.	Total.	Number of cases.	Amount of fines or collateral.	Total.
1	\$5.00	\$5.00	4	\$100.00	\$400.00
1	10.00	10.00	1	200.00	200.00
2	15.00	30.00	1	2,800.00	2,800.00
42	25.00	1,050.00			
12	50.00	600.00			5,095.00

Six hundred notices of judgment were published during the year and 1,330 were prepared for publication. Briefs were prepared in five cases at the requests of United States attorneys.

**FOOD AND DRUGS CASES OF INTEREST.**

In the case of *Bradley v. U. S.* (264 Fed. Rep. 79), which was the outgrowth of a seizure proceeding based on Food and Drugs No. 8752, N. J. No. 6623, the Circuit Court of Appeals for the Fifth Circuit, in affirming the decree of the lower court, held that in a suit to condemn mineral water shipped in interstate commerce under a label stating that it was recommended in the treatment of certain diseases, whether this was a representation that the water had curative or therapeutic qualities was a question for the court, but the falsity or truth of such representation and the intent of the claimant were questions for the jury to find from the testimony before it.

The court further held that the words "recommended in the treatment of Bright's disease," etc. "Directions \* \* \*" could only mean that the use of the water in the treatment of the diseases <sup>referred</sup> would effect a cure or alleviation of such diseases; otherwise, <sup>they</sup> <sup>could</sup> recommend it? Unless this means that the water did contain elements or ingredients which would alleviate or cure the diseases named, when taken according to the directions thereon contained, it was a waste of printer's ink.

It was further held that where a claimant shipped water in interstate commerce under a label representing that it possessed curative or alleviative qualities, he could not deny that it was a drug within the meaning of the food and drugs act, section 8, subdivision 3, as to the misbranding of drugs; that to confine the meaning of the word "drugs," as used in said subdivision of section 8, to any definition of "drug" found in dictionaries or pharmacopœias would, in the judgment of the court, be entirely too narrow.

The court further held that if the allegations of the libel were true the claimant has put the substance, water, in interstate commerce with the recommendation that it possessed certain elements or ingredients which were curative or at least alleviative for the diseases named in the label and that he would not be heard then to say that

the substance recommended was water and not a drug; that such a construction would nullify the act of Congress.

It was further held that in a suit to condemn mineral water evidence tending to show its shipment in interstate commerce under a label stating that it was recommended for certain diseases, analysis of the water and the absence of any medicinal ingredients having curative or alleviative properties in the treatment of such diseases, and the claimant's position respecting the article, made a question for the jury as to whether the claims on the labels were true, and if false, whether they were made knowingly and fraudulently.

It was further held that the refusal or granting of a motion for a new trial is in the discretion of the trial judge and can not be reviewed on writ of error or appeal.

In the case of the *U. S. v. 2 Cans of Oil of Sweet Birch and 3 Cans of Oil of Gaultheria* (F. & D. 11651, N. J. 7691), a seizure proceeding instituted in the southern district of New York, Judge Hand, in denying claimant's motion for the release of the product under bond, held that in his opinion the release of the articles was discretionary with the court; that the language of the act making provision for the release of articles seized was not mandatory but clearly permissive; and that he regarded the application for the release of the goods as addressed wholly to his discretion, and he declined to exercise it in favor of the claimant under the existing circumstances, which showed that the misbranding was fraudulent and injurious to competition in the trade.

In the case of the *United States v. Antonio Scaduto*, trading as Scaduto & Co. (F. & D. 10298, N. J. 7708), involving the shipment of two different brands of oil, the defendant contended with regard to both brands that his labeling as to the net contents of the cans, based on the trade custom of  $7\frac{1}{2}$  pounds of cottonseed oil to the gallon, was true. The court instructed the jury that it was not a question of the intention of the defendant, but was a question of what, in view of all the facts, was the truth; that the defendant had no right, whether he was innocent of purpose or not, under the food and drugs act, to make an incorrect representation as to the contents of his can.

With regard to the brand of oil, which was labeled, among other things, "Cotton Seed Oil Slightly flavored with Olive Oil," in inconspicuous type, but which also bore the words "Termini Imerese" and a representation of natives gathering and packing olives, the court instructed the jury that the question for them to determine, based on business experience and common sense, was, What would the person, the purchaser, a member of the public getting that kind of a can, upon such examination as they would be likely to give it, say about it? The court further reminded the jury of the query of the Government as to "What could have been the object of putting this tree and the 'Termini Imerese' on?" and stated to them that there was no proof that any cottonseed oil ever came from that part of the world, in Sicily, and put to them the inquiry, "What would it mean except that this was olive oil?" The court further emphasized that the question for the jury was whether the statement as to the contents of the can was correct, and whether the picture and descriptive words on the other can, indicating or not indicating, as

the jury might think, its origin, were correct; that if the defendant put it out and traded in it, even though he did not know it, he must know it; that it is not a question of a man's motive; that the food and drugs act is for the purpose of protecting the people and seeing that the public gets fair statements as to weights, origins, and the like; that the act should be administered, both by the courts and juries, in a rational and sensible way.

In the case of *United States v. John Jacobson* (F. & D. 10113, N. J. 7735), involving the shipment of alleged condensed milk, the court charged the jury that if they found upon the testimony that the butter fat of the milk had been removed and that other butter fat had been substituted in sufficient amount to meet the minimum requirement as to butter fat in condensed milk but in a lesser amount than the amount which was removed, that such treatment constituted adulteration for the reason that a valuable constituent of the product had been abstracted, and that it would be the duty of the jury to find the defendant guilty. It was further charged that if a part of the butter fat had been removed from the product which was labeled "Regular Condensed Milk" and the milk had not been made from the whole milk it was misbranded within the meaning of the act.

In the case of the *United States v. Kar-Ru Chemical Co.* (264 Fed., 921) the judgment of conviction of trial court was affirmed in the Circuit Court of Appeals for the ninth circuit. The claim of the defendant was that the case involved a controversy relating to the efficacy of the homeopathic remedies and that the theories of the prosecution arose on the testimony of its medical witnesses that homeopathic remedies were worthless. The court stated that the "defendant having defended on the ground that the preparations were remedies in accordance with the theory and practice of homeopathy, that question became a question of fact for the jury to be determined under proper instruction from the court," and that the instructions by the trial court were in accordance with the law as declared by the Supreme Court in the case of seven cases of *Eckman's Alteratives v. United States* (239 U. S., 510).

In the case of the *United States v. One Gross Packages of "Texas Wonder"* (F. & D. 9322), the court instructed the jury that the statement on the carton "A Texas Wonder, Hall's Great Discovery \* \* \* for kidney and bladder troubles, diabetes, weak and lame backs, rheumatism," was not a statement that the article was a specific for the cure of those diseases, but was a statement that it was recommended that it would have a therapeutic or curative effect in the treatment of those diseases, and that the statement that the article dissolves gravel was a statement of fact, and affirmative assertion of the originator of the compound that it would have the effect, if taken according to directions, of dissolving gravel in the bladder, and also that it was a statement of fact that the article would have the effect of regulating bladder trouble in children. The court further instructed the jury that if it should find that the labeling constituted a false statement, in passing on the question of whether it was fraudulent, they might take into consideration the chemical contents of the concoction as proven and whether a man without chemical knowledge or without experience, as the manufacturer admitted he was, could medicinally understand the effects of such drugs



as this concoction is shown to have had in it. The jury was also instructed that the controlling element that entered into the question of fraudulent intent was as to whether or not the claimant honestly believed that this concoction would have a remedial or therapeutic effect upon the persons suffering with the diseases named on the cartons; that if he believed that, and if the jury should find that it was an honest transaction in that respect, then he would not be guilty of fraudulent intent; and that in passing upon that question they should take into consideration all the facts in the case and determine as to whether the manufacturer's knowledge was that of a person who understands the effect of the article or whether or not it was the statement of a mere fakir or charlatan who desires to impose on the public a formula for sale for the making of money.

In the case of the *United States v. Newton Tea and Spice Co.* (F. & D. 11048, 11123), involving the shipment of an article labeled in part "Eggno An Excellent Substitute for Eggs," the defendant voluntarily appeared and moved to quash the information upon the grounds that the information was indefinite and did not apprise the defendant of the facts constituting the alleged crime with such certainty and particularity as to enable the defendant to know what he had to meet; that the information attempted to charge the defendant with the commission of a crime by way of argument and conclusion; and that the court had no jurisdiction. The information alleged that the statements on the label of the article were false and misleading in that they represented to the purchasers that the article was a substitute for eggs and could be used in place of eggs in baking and cooking, whereas in truth said article was not a substitute for eggs, nor could the same be used in place of eggs in baking and cooking. The ground of defendant's contention, with regard to this charge, was that the information did not set forth why or in what manner the article could not be used as a substitute for eggs in baking and cooking. The court held that the statements on the label were evidently designed to lead the ordinary housewife to believe that the contents of the package could be used in substitution for eggs in the ordinary preparation of food and that the information expressly negated the use of the article for that purpose and that it would seem therefore to be entirely sufficient to try the issue upon that question.

Upon the defendant's contention that the court had no jurisdiction for the reason that the information did not state the offense, the court said:

Even though we assume it to be the duty of the pleader under this act to negative the terms of the proviso or assume that the article in question is shown by the label to be a mixture or compound known as an article of food under its own distinctive name, not alleged to be in imitation of another, nevertheless the protection afforded by this proviso goes only to the branding or name of the article and does not furnish a refuge for one who has on the label otherwise falsely stated the nature of the contents of the package. It is not against the use of the name "Eggno" that the information is directed, but against the statement that the contents are useful and fit to be substituted for eggs in ordinary cooking recipes.

Upon the defendant's contention that the statement "Substitute for Eggs in Baking and Cooking" was not one of fact, but of opinion only, and therefore not in law misleading; that the substitution of one thing for another is largely a matter of judgment, and that to call

a thing a substitute is not to affirm that it is even similar to the original; that one article of diet may be substituted for another without any necessary similarity, the court found that nothing else could be inferred but that in ordinary compounds the article in question would produce results the same as or similar to eggs. Upon defendant's contention that the mere representation as to the results that might be obtained by the use of the article does not constitute misbranding within the act, relying on *United States v. Johnson* (221 U. S., 448), the court stated that the terms of the act at that time were very much narrower in scope with regard to drugs than with regard to food; that with regard to food, the act makes it an offense if the package containing it or its label shall bear any statement, design, or device regarding the ingredients of substances contained therein, which statements, designs, and devices shall be false and (or) misleading in any particular. Upon defendant's contention that the information, not being upon oath, was violative of the fourth amendment, and for that reason defendant should not be held to answer, the court reaffirmed the doctrine laid down in *Weeks v. United States* (216 Fed., 292) that the information is not required to be upon oath; is only required to be supported by oath before warrant may be issued thereon; and as the defendant has voluntarily appeared and filed the motion to quash, no question of validity of a warrant can be raised.

#### AMENDMENT OF THE FOOD AND DRUGS ACT.

The food and drugs act was amended by the appropriation act for the Department of Agriculture for the fiscal year ended June 30, 1920, approved July 24, 1919 (66th Cong., 1st sess., H. R. 7413), as follows:

That the word "package" where it occurs the second and last time in the act entitled "An act to amend section 8 of an act entitled 'An act for preventing the manufacture, sale, or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and for regulating traffic therein, and for other purposes,' approved March 3, 1913," shall include and shall be construed to include wrapped meats inclosed in papers or other materials as prepared by the manufacturers thereof for sale.

#### MEAT INSPECTION ACT.

(34 Stat., 674.)

Thirty-five cases were reported to the Attorney General. At the close of the fiscal year 1919 thirty-seven cases were pending.

Of the cases reported during the fiscal year 1920, 5, and of those pending at the close of the fiscal year 1919, 6, in all, 11, were terminated during the fiscal year 1920, all of which resulted in convictions. Fines aggregating \$485 were imposed in 11 cases, as follows:

#### *Fines imposed in meat-inspection cases.*

Cases.	Fine.	Total.
2	\$10	\$20
1	15	15
5	25	125
1	50	50
1	125	125
1	150	150
11	.....	485

At the close of the fiscal year 1920, 61 cases were pending.

**TWENTY-EIGHT HOUR LAW.**

(34 Stat., 607.)

One thousand four hundred and fifty-nine cases were reported to the Attorney General for action, 37 of which represented 108 violations, and 1,798 were reported to the Director General of Railroads—in all, 3,257 reported during the fiscal year. This is an increase over the preceding year of 134 cases reported for action.

Of the cases reported during the fiscal year 1920, 197, and of those pending at the close of the fiscal year 1919, 434, in all 631, were terminated by the imposition of penalties. Three hundred and sixty-two cases were terminated by dismissal.

At the close of the fiscal year 1920, 1,894 cases were pending.

During the year penalties aggregating \$67,700 were collected in 631 cases.

Following is a detailed table of the number of cases prosecuted and the amounts of penalties assessed:

*Cases prosecuted and penalties imposed under the 28-hour law.*

Number of cases.	Fine.	Total amount.
539	\$100	\$53,900
1	150	150
10	200	2,000
2	250	500
1	300	300
1	350	350
2	400	800
4	475	1,900
171	.....	7,800
631	.....	67,700

<sup>1</sup> Lump fine.

A number of conferences with attorneys for railroads and Department of Justice officials were attended during the year in an effort to settle various cases arising out of the difficulties imposed upon the railroads by war conditions. The conferences resulted in settlements satisfactory alike to the Government and the carriers.

**ACTS REGULATING THE INTERSTATE MOVEMENT OF LIVE STOCK FROM QUARANTINED DISTRICTS, PROHIBITING THE INTERSTATE MOVEMENT OF DISEASED LIVE STOCK, AND PROHIBITING THE IMPORTATION OF DISEASED LIVE STOCK.**

(23 Stat., 31; 26 Stat., 414; 32 Stat., 791; 33 Stat., 1264.)

Thirteen cases involving violations of the act of May 29, 1884 (23 Stat., 31), were reported to the Attorney General for prosecution. Of these, two were terminated by fines of \$100 each and five by fines of \$100 and costs each. Two cases were dismissed. Of the cases pending at the close of the fiscal year 1919, three were terminated by fines of \$300, \$500, and \$100, respectively, and one by a fine of \$100 and costs. One case was dismissed.

No cases were reported to the Attorney General under the act of August 30, 1890 (26 Stat., 414).



Four cases against individuals were reported to the Attorney General for prosecution under the act of February 2, 1903 (32 Stat., 791), of which one was terminated by a fine of \$100 and costs and two were dismissed. Of the cases pending at the close of the fiscal year 1919, nine were terminated by fines of \$100 and costs each and one by a fine of \$250 and costs, and 19 cases were nolle prossed. No cases under this act were reported to the Director General of Railroads. All cases previously reported to the Director General of Railroads were given consideration by him during the year and disposed of.

Two cases were reported to the Attorney General charging a violation of the act of March 3, 1905 (33 Stat., 1264). In one of these cases the jury rendered a verdict of not guilty. Of the cases pending at the close of the fiscal year 1919, 34 were terminated by fines, as follows: Seventeen, \$100 and costs each; 14, \$100; 1, \$150 and costs; 1, \$50 and costs; 1, \$25 and costs. Nine cases were dismissed. Eleven cases under this act were reported to the Attorney General for transmission to the Director General of Railroads. These cases, together with those transmitted during and pending at the close of the fiscal year 1919, were given consideration by the Director General of Railroads and disposed of.

The fines imposed under the animal-quarantine laws were:

*Fines imposed under animal quarantine laws.*

Number of cases.	Amount of fines.	Total.
1	\$25	\$25
1	50	50
50	100	5,000
1	150	150
1	250	250
1	300	300
1	500	500
56	.....	6,275

In each of the cases reported to the Attorney General for prosecution under the acts of May 29, 1884, February 2, 1903, and March 3, 1905, a suggested form of indictment or criminal information was prepared and submitted therewith for use by the United States attorneys.

#### THE VIRUS ACT.

(37 Stat., 832.)

One violation of the act of March 4, 1913 (37 Stat., 832), consisting of transporting interstate a quantity of serum which was not prepared at a Federal licensed establishment and which was worthless, dangerous, and harmful, was reported during the fiscal year 1920. This case was terminated by the payment of three fines of \$500 each by the three defendants.

Of the cases under this act which were pending at the close of the fiscal year 1919, one apparent violation was dismissed. A plea of guilty was entered in the case of another violation involving the shipment and delivery for shipment interstate of several quantities of virus or analogous products by an establishment not holding an un-

suspended or unrevoked license issued by the Secretary of Agriculture. A fine of \$10 and costs was assessed in this case.

### THE INSECTICIDE ACT.

(36 Stat., 331.)

One hundred and fifty-four cases were reported to the Attorney General, in 134 of which criminal proceedings and in 20 of which seizures were recommended. At the close of the fiscal year 1919, 80 cases were pending, 74 of which were criminal prosecutions, and 6 of which were civil, or seizure, cases. Forty-four cases pending at the close of the year 1919, and 69 reported during the year ending June 30, 1920, in all, 113, were terminated during the year. Of the cases terminated, 94 were criminal and 19 were civil. In the 94 criminal cases, fines were imposed in 79, and 15 were dropped or dismissed. In 71 cases pleas of guilty and in 6 pleas of nolo contendere were entered, and in 2 trials and convictions were had.

In the criminal cases in which convictions were obtained, the fines were as follows:

#### *Fines assessed under the insecticide act.*

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
1	\$1.00	\$1.00	1	\$45.00	\$45.00
2	2.50	5.00	6	50.00	300.00
1	5.00	5.00	1	75.00	75.00
17	10.00	170.00	3	100.00	300.00
5	15.00	75.00	2	750.00	1,500.00
10	20.00	200.00			
28	25.00	700.00	79	.....	3,436.00
2	30.00	60.00			

Costs were assessed in a number of cases in which convictions were obtained. Decrees of condemnation and forfeiture were entered in 19 civil or seizure cases. At the close of the year 121 cases were pending, of which 114 were criminal prosecutions and 7 were seizures. One hundred notices of judgment were prepared.

### THE MIGRATORY BIRD TREATY ACT.

(40 Stat., 755.)

Five hundred and forty-five cases were reported to the Department of Justice. At the close of the preceding fiscal year 175 cases were pending, of which 128 were closed during the fiscal year, 85 by convictions and the imposition of fines, 1 by forfeiture of \$100 collateral, 1 by death of the defendant, and 41 by failure of the grand jury to indict, or by dismissal. A number of cases wherein the grand jury failed to indict have been resubmitted for trial on information.

Of the 545 cases reported during the year 356 were closed, 298 by the imposition of fines, 6 by condemnation and forfeiture, 2 by discharge of the defendants upon payment of substantial costs, 1 by sentence of the defendant to imprisonment for nine months in jail, 1 by suicide of the defendant, 1 by combination with a case under section 84 of the Penal Code, which was prosecuted under the latter

section and terminated by a fine, 1 by verdict of not guilty as the result of a jury trial, 10 by failure of the grand jury to indict, and 36 by dismissal. Nineteen of the dismissed cases represented offenses growing out of the mistaken but bona fide belief by defendants that regulation 4 of the migratory-bird regulations was to be amended to permit the possession of birds legally killed for an additional period beyond the 10-day limit. The birds involved in these 19 cases were turned over to charitable institutions. In one of the cases reported as terminated by a fine aigrettes to the value of \$10,000 were confiscated, and in another the defendant, in addition to being fined, was sentenced to jail for one week. Two hundred and thirty-six cases were pending at the close of the fiscal year.

*Fines imposed under the migratory bird treaty act.*

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
10	\$1.00	\$10.00	3	\$40.00	\$120.00
3	2.00	6.00	27	50.00	1,350.00
2	2.50	5.00	5	75.00	375.00
1	4.00	4.00	8	100.00	800.00
58	5.00	290.00	2	200.00	400.00
138	10.00	1,380.00	3	250.00	750.00
4	15.00	60.00	1	300.00	300.00
64	20.00	1,280.00	1	500.00	500.00
48	25.00	1,200.00			
1	26.00	26.00	383	.....	8,976.00
4	30.00	120.00			

### THE LACEY ACT.

(35 Stat., 1137.)

Twenty-eight cases were reported to the Department of Justice. At the close of the preceding fiscal year 29 cases were pending, of which 20 were terminated during the fiscal year, 12 by convictions and the imposition of fines and 8 by dismissal or abatement on account of age.

Of the 28 cases reported during the year 13 were closed, 11 by convictions and the imposition of fines, 1 by dismissal, and 1 on account of the death of the defendant. Twenty-four cases were pending at the end of the year. Fines were imposed as follows:

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
1	\$5	\$5	1	\$100	\$100
3	10	30	1	150	150
11	25	275	1	250	250
1	35	35			
3	50	150	23	.....	1,070
1	75	75			

### BIRD RESERVATION TRESPASS LAW.

(35 Stat., 1104.)

Three cases were reported to the Department of Justice, and resulted in convictions. In two fines were imposed and in the third both defendants were sentenced to three months each in jail.



*Fines imposed under the bird reservation trespass law.*

Number of cases.	Amount of fine.	Total.
1	\$10	\$10
1	25	25
2	.....	35

**NATIONAL FOREST GAME REGULATIONS.**

(Regulation T-7.)

Thirteen cases involving hunting and fishing on national forests in violation of State laws were reported to the Department of Justice. Of these, three were closed, two by conviction and the imposition of fines and one by dismissal. The remainder were pending at the close of the year. Fines were imposed as follows:

*Fines imposed in cases involving game violations on national forests.*

Number of cases.	Amount of fine.	Total.
1	\$20	\$20
1	100	100
2	.....	120

**PISGAH GAME PRESERVE LAW.**

(39 Stat. 476.)

Four cases were reported to the Department of Justice. At the close of the preceding fiscal year six cases were pending, of which five were closed during this fiscal year, two by conviction and the imposition of fines of \$10 each, and three by dismissal. None of the four cases reported during the year was terminated. Five cases were pending at the close of the year.

**UNITED STATES COTTON FUTURES ACT.**

(39 Stat. 476, as amended; 40 Stat. 1351.)

A doubt having arisen as to the permanency of the amendments of the cotton futures act contained in section 6 of the wheat guaranty act of March 4, 1919 (40 Stat. 1348, 1351), the department recommended to Congress that appropriate action be taken to remove the doubt. This resulted in the inclusion of a proviso in the agricultural appropriation act of May 31, 1920, declaring the amendments to be permanent.

Aid was given in the preparation of suggested amendments to the act to include American-Egyptian cotton and in the preparation of several amendments to the regulations under the act. Assistance was given the future exchanges in amending their rules to conform to the act as amended, and to the Bureau of Markets in its cotton classification work, and in the establishment by the bureau of a spot-cotton quotation service.

The office participated in the consideration of 10 disputes under the act in settlement of contracts entered into before the amendments of March 4, 1919, became effective.

### UNITED STATES GRAIN STANDARDS ACT.

(39 Stat. 482.)

Assistance was given to the Bureau of Markets in the preparation of tentative standards for rice, and hearings were attended in seven markets in reference thereto. Aid was given in the preparation of amendments of the regulations under the act. Consideration was given to a general revision of the regulations, and a conference of grain supervisors at Chicago was attended.

Consideration was given to 57 possible violations of the act, of which 4 were reported to the Department of Justice for prosecution, resulting in 2 convictions and the imposition of fines amounting to \$100 in one case and \$200 in the other. Aid was given the United States attorney in the trial of one of the cases. Findings of fact were published in 6 cases. Consideration was given to the suspension and cancellation of a number of licenses under the act. In proceedings in alleged violations of the act by shippers and against inspectors, the records were reviewed and notices and letters were prepared upon request of the Bureau of Markets. Two hearings held in connection with such alleged violations were attended. The records in 540 appeals involving the grading of shelled corn, wheat, and oats, under the act, were reviewed.

Consideration was given to a change in the method of handling appeals under the act and to a revision of a number of forms used in such appeals; also to the suggested form of grain inspection certificates to be used by inspectors licensed under the act.

In cooperation with the Bureau of Markets, a method of handling intrastate "appeals" was devised.

The office participated in conferences with the Secretary, the Bureau of Markets, and committees representing the northwestern and southwestern grain interests regarding a possible revision of the official wheat standards of the United States, and aid was given in plans for the cooperative demonstration of the wheat grades in Kansas, Oklahoma, and other States.

Various opinions on questions arising in the administration of the act and regulations, such as inspection requirements for Canadian grain passing through the United States, seaboard inspection requirements of export grain, and whether or not milled rice is a grain within the meaning of the act, were prepared, revised, or approved. Four service and regulatory announcements and various bulletins of the Bureau of Markets containing opinions and information relative to the act were examined and changes suggested when necessary.

### UNITED STATES WAREHOUSE ACT.

(39 Stat., 486, as amended; 41 Stat., 266.)

Assistance was given to the Bureau of Markets in the preparation of regulations for grain and for wool warehouses under the act. Hearings were held in 16 markets in connection with the regulations for grain warehouses and in 10 markets in connection with the regula-

tions for wool warehouses. Aid was given in a general revision of the regulations for cotton warehouses. Preliminary to the preparation of tentative regulations for wool warehouses one of the lawyers of this office accompanied representatives of the Bureau of Markets in an investigational trip to 4 wool markets.

Consideration was given to the preparation of regulations for tobacco warehouses under the act, in connection with which this office and the Bureau of Markets were represented at four tobacco markets.

Aid was rendered the Bureau of Markets in conferences and correspondence with members and representatives of the Federal Reserve Board relative to a preferential rate on paper secured by receipts issued under the act and regulations.

The office prepared for the use of the Bureau of Markets summaries of the Minnesota and North Dakota grain laws, with special reference to the points of possible conflict between the State laws and the Federal act.

The office reviewed for legal sufficiency 39 records of applications for cotton, grain, and wool warehouse licenses, and 44 records of applications for licenses to classify or to weigh cotton and to inspect, grade, and certificate the grade of grain; and assisted in the preparation of 21 forms for use in the administration of the act and regulations, including special forms for use in connection with warehouses under the North Carolina State warehouse system.

Various opinions on questions arising in the administration of the act and regulations were prepared, revised, or approved, and one service and regulatory announcement and several bulletins were examined and changes suggested when necessary.

#### STANDARD CONTAINER ACT.

(39 Stat., 673.)

Various general legal matters under the act were considered and advice given thereon.

#### FOOD CONTROL ACT.

(40 Stat., 276.)

Other items of work under this act not mentioned in the summary were the following:

Considerable assistance was given to the Bureau of Markets relative to matters growing out of the licensing of stockyard operators and others handling or dealing in live stock in connection with stockyards. Charges against 17 licensees under the presidential proclamation were prepared or reviewed and oral hearings held.

In the administration of the licensing of dealers in fertilizer and fertilizer ingredients a number of legal questions were presented, which were considered in conference and correspondence. Among the more important questions considered were the labor and car situations in the phosphate fields, the borax content of potash salts, and general supervision of the prices of fertilizers.

Assistance was given the administrative heads of the department relative to various matters arising under the proclamation of the President licensing the farm-implement industry, including com-



plaints of alleged discriminations by farm implement manufacturers against farmers' organizations.

Assistance was given to an employee of the Bureau of Markets in two actions for damages growing out of his activities as a Government official in connection with the distribution of hay and feed in the drought-stricken areas in Montana. After various conferences and correspondence one of the cases was compromised and plaintiff dismissed the other.

#### MISCELLANEOUS WORK FOR THE BUREAU OF MARKETS.

Various letters, memoranda, news items, manuscripts, service, and regulatory announcements, and proofs of bulletins (including an elaborate bulletin on future trading), relating to the work of the Bureau of Markets, were prepared, approved, or revised. Questions relating to the conduct of cooperative work between the grain corporation and State agencies and this department were considered in conferences and correspondence. Consideration was given to the form and manner of operation of cooperative agricultural associations. Aid was given in the consideration of the provisions of the New York State law in the matter of the cold storage of fish, of questions arising out of alleged unfair practices of certain organizations of milk producers, and of questions arising out of alleged grain exchange manipulations.

#### PATENTS.

Twenty-two applications for letters patent on inventions of employees of the department for dedication to the public were prepared and filed. During the year 17 were allowed and 10 disallowed.

The following table shows the status of applications on June 30, 1920:

*Patents applied for by members of the department.*

Applicant.	Bureau.	Invention.	Disposition of application.
Marion Dorset and Howard J. Shore.	Animal industry.....	Process for the manufacture of concentrated hog-cholera antitoxin.	Disallowed.
Chas. S. Reeves, Provost Hubbard, and Richard H. Lewis.	Public Roads and Rural Engineering.	Process for preparing water-proof paving material.	Do.
Wm. G. Taggart.....	.....	Method of manufacturing decolorizing carbon.	Pending in interference.
J. A. Ambler and H. D. Gibbs.	Chemistry.....	Process for the manufacture of naphthalene sulphonic acids.	Do.
G. Archie Russell.....	Plant Industry.....	Tree trimming and harvesting machines.	Pending.
Geo. R. Goergens.....	Publications.....	Panoramic camera attachment.	Do.
Bohart and Gibbs.....	Chemistry.....	Manufacture of hydrochloric acid	Disallowed.
Yoder and Langley.....	Plant Industry.....	Cane stripping comb.....	Allowed.
Ambler, Lubs, and Gibbs.	Chemistry.....	Manufacture of cymeno sulphonic acid.	Do.
J. N. Carothers.....	Soils.....	Manufacture of nitrogen fertilizer	Disallowed.
R. F. Gardiner.....	do.....	Manufacture of synthetic ammonia.	Allowed.
H. D. Gibbs and E. Q. Adams.	Chemistry.....	Process of sublimation.....	Pending in interference.
H. D. Gibbs.....	do.....	Process of purifying anthracene press cake.	Disallowed.
Wise and Adams.....	do.....	Photographic sensitizing dyes...	Allowed.
Gibbs & Ambler.....	do.....	Benzene sulphonic acid.....	Disallowed.
G. E. Sanders.....	Entomology.....	New insecticide.....	Allowed.

*Patents applied for by members of the department—Continued.*

Applicant.	Bureau.	Invention.	Disposition of application.
K. P. Monroe.....	Chemistry.....	Adhesive.....	Pending.
Adams and Wise.....	do.....	Photograph sensitizing dyes.....	Allowed.
Ambler and Gibbs.....	do.....	Aromatic sulphonic acids.....	Disallowed.
Davis and Bryan.....	Soils.....	Production of ammonia.....	Allowed.
Gibbs, Ambler, Colton, and Senseman.....	Chemistry.....	Sulphonic acid compounds.....	Disallowed.
C. Conover.....	do.....	Apparatus for controlling reactions between gases.....	Pending.
Do.....	do.....	do.....	Do.
E. G. Beinhart.....	Plant Industry.....	Curing tobacco.....	Allowed.
E. F. Gardiner.....	Soils.....	Synthetic ammonia.....	Do.
F. Daniels.....	do.....	Ammonium nitrate.....	Pending.
C. G. Bates.....	Forest Service.....	Atmometer.....	Allowed.
L. Weisberg.....	Chemistry.....	Acetic anhydride.....	Disallowed.
W. G. Waggaman.....	Soils.....	Phosphorus and phosphorus acid.....	Allowed.
H. C. Gore.....	Chemistry.....	Dextrin.....	Do.
William H. Ross.....	Soils.....	Process for removal of hydrofluoric acid from phosphoric acid.....	Do.
Ernest Bateman.....	Forest Service.....	Bleaching wood.....	Do.
Max Phillips.....	Chemistry.....	Improvement in the synthetic manufacture of thymol.....	Do.
Winston and Yothers.....	Plant Industry.....	Insecticide and fungicide.....	Pending.
Elnathan K. Nelson.....	Chemistry.....	Vanillyl amin, vanillyl acyl amids and production thereof.....	Allowed.
Ovid M. Butler.....	Forest Service.....	Signs and processes of making same.....	Disallowed.
Boerner and Ropes.....	Markets.....	Grain samplers.....	Pending.
Bruce Drummond.....	Plant Industry.....	Support for stalks or branches of fruit trees.....	Do.
John F. Barghausen.....	Markets.....	Fruit grader and sizer.....	Allowed.
Herbert C. Gore.....	Chemistry.....	Malt sirup.....	Pending.
Do.....	do.....	do.....	Do.
Albert C. Weimar.....	Animal Industry.....	Process of extracting soluble albumen from whey.....	Do.
K. P. Monroe.....	Chemistry.....	Manufacture of furfural and volatile organic acids from corn cobs.....	Do.
Do.....	do.....	Manufacture of furfural and volatile organic acids from corn cob pentosan.....	Do.
Charles Brooks.....	Plant Industry.....	Preserving apples.....	Do.
Elihu H. Ropes.....	Markets.....	Grain sampler.....	Do.
Edward M. Chace.....	Chemistry.....	Apparatus for sterilizing fruit juices.....	Do.
Carl O. Johns and Abraham J. Finks.....	do.....	New and improved types of bread.....	Do.
Herbert C. Gore.....	do.....	Manufacture of sweet potato sirup.....	Do.
S. F. Sherwood.....	do.....	New process for preparing sirup from sugar beets.....	Do.
Adams and Haller.....	do.....	Photosensitizing dyes of the Isocyanine type.....	Do.
Claude R. Smith.....	do.....	Substance, gelatin or glue free from mineral matter, acids or alkalies, and a process for preparing same.....	Do.





## REPORT OF THE INSECTICIDE AND FUNGICIDE BOARD.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
INSECTICIDE AND FUNGICIDE BOARD,  
*Washington, D. C., September 24, 1920.*

SIR: I have the honor to submit herewith the report on the work of the Insecticide and Fungicide Board for the fiscal year ended June 30, 1920.

Respectfully,

J. K. HAYWOOD,  
*Chairman of Board.*

HON. E. T. MEREDITH,  
*Secretary of Agriculture.*

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The board was inaugurated to assist the Secretary of Agriculture in the enforcement of the insecticide act of 1910. The purpose of this act is to prevent the manufacture, sale, or transportation of adulterated or misbranded Paris greens, lead arsenates, and other insecticides, and also fungicides (including disinfectants), and for regulating traffic therein. The act has been in effect since January 1, 1911, and the enforcement has resulted in greatly improving the quality of proprietary insecticides and fungicides and in making their labels truthful representations of their efficiency.

The industry regulated by this act has experienced a tremendous growth, with a consequent increase in the work of the board. It has developed from a side-line business to one attracting the investment of a large amount of capital and the erection of many plants for the manufacture of an increasing variety of preparations. Through the efforts of scientific investigators new methods of controlling insects and fungi have been developed and the industry is of constantly increasing economic importance. The overcoming of losses to crops and animals through the application of proper remedies has come to be regarded as an important part of commercial farming and stock raising, and the use of the materials controlled by this act has consequently become more general and the tonnage entering interstate commerce is now very large.

New household insecticides and general disinfectants are constantly found on the market, and their use appears to be increasing every year. Large quantities of cattle dips, sheep dips, and preparations for use on poultry and domestic animals are found on the market which require inspection, and the facilities of the board are fully employed in collecting and examining samples of the various preparations, many of which contain new combinations of ingredients.

During the year it was noted that a considerable number of disinfectant manufacturers were adulterating their so-called "pine oil" disinfectants with mineral oil; also some manufacturers of so-called "coal-tar disinfectants" were adulterating these with mineral oil. Several cases involving such adulteration were referred to the Department of Justice to institute prosecution.

The campaign started during the fiscal year 1919 against insect-powder adulteration with powdered daisies was continued during the fiscal year 1920. As a result of this campaign this form of adulteration appears to have markedly decreased. Since the price of insect powder has been so high there has been a marked tendency for certain manufacturers to adulterate their insect powder with insect flower stems or other cheap adulterants. A considerable number of such cases as this have been forwarded to the courts for prosecution.

The campaign against adulterated and misbranded disinfectants has been continued during the year, and a considerable number of disinfectant cases have been forwarded to the courts for prosecution. In some of these the manufacturers claimed phenol coefficients much higher than were shown by a test of their goods; in others preparations were recommended as disinfectants which in fact possessed no disinfecting qualities; but the principal fault in these preparations lay in the very exorbitant and faulty claims made for the products in the labels and literature. While a considerable improvement in the preparation and labeling of disinfectants has been brought about as a result of the enforcement of the insecticide act, this class of preparations should and will receive further control and regulation under the provisions of the act.

The campaign to improve the quality of Bordeaux and Bordeaux-lead arsenates sold on the American market and secure such correction of the labeling of these products that they will be effective as fungicides when used at the dilutions recommended has been continued. A marked improvement in the quality and labeling of these preparations has been brought about as the result of the activities of this board. However, some of these preparations are still of poor quality and will not do what is claimed for them. Field tests are being made to enable the board to proceed against such of the Bordeaux and Bordeaux-lead arsenates on the market as are misbranded or adulterated, or both, under the provisions of the insecticide act.

During the fiscal year 1919 a campaign was inaugurated which had for its purpose the inspection of calcium arsenate used for cotton-boll-weevil control. After years of experimentation on the part of the Bureau of Entomology, a remedy for the cotton-boll weevil was finally found in the product calcium arsenate. However, such calcium arsenate, when applied as a dust, in order to be effective against the cotton-boll weevil and yet not injurious to the cotton plant, must be up to a certain standard for total arsenic, must not contain more than a very small amount of arsenic in water-soluble forms, and must be of about a certain density. As a result of the discovery that calcium arsenate would control cotton-boll weevil, about 3,000,000 pounds of it were manufactured and shipped to the South during the 1919 cotton-growing season. The campaign carried on to control the purity under the provisions of the insecticide act showed that

many of the shipments of calcium arsenate contained so much water-soluble arsenic that they would seriously injure or kill the cotton plants on which they were used, and some shipments contained much less than the standard amount of total arsenic pentoxid, the constituent which measures the insect-killing power of the article. A considerable number of seizures were made, thus preventing the use of this substandard material, and the manufacturers were, or are, being prosecuted.

During the 1920 cotton-growing season it is estimated that fully 10,000,000 pounds of calcium arsenate have been shipped to the South for cotton-boll-weevil control. In the early summer of 1920 all the inspectors who could possibly be spared were directed to give their entire attention to the calcium-arsenate situation, working in cooperation with the field agents of the Bureau of Entomology. They have covered all the Southern States where calcium arsenate is sold and have sent in samples for chemical analysis in order to determine its standard and purity and for test in the field by the Bureau of Entomology in order to determine its burning properties. The calcium-arsenate inspection work up to date clearly indicates that a very extensive and complete control will have to be maintained over all the calcium arsenate sent to the South. While, as a whole, this commodity appears to be less seriously adulterated and misbranded than it was in 1919, yet a considerable number of shipments, in whole or in part, are below standard in some respect. It is the intention of the board to continue its practice of inspecting shipments of this insecticide with a view to recommending the seizure of all such as are found to be injurious to the cotton plant or ineffective against the weevil.

#### INTERSTATE SAMPLES.

During the fiscal year the board reported to the Solicitor of the department 124 cases presenting alleged violations of law, with recommendation that the facts be transmitted to the Attorney General to institute criminal action or seizure proceedings. Disposition was made of 120 cases by correspondence with the manufacturers. These cases presented violations which were technical only, not flagrant, or cases in which the manufacturer gave reasonable and adequate explanation of his failure to conform to the provisions of the act. Action was taken to place in abeyance 524 samples which, upon examination and test, were shown to be in compliance with the provisions of the law or were from shipments of the same goods made prior to shipments for which the manufacturer had been convicted and had, after citation, conformed to the requirements of the law. On June 30, 1920, 79 cases were pending preliminary hearings or before the board for final action, 251 were held in temporary abeyance pending the receipt of further information or the outcome of prosecutions based on the same product or correspondence with the manufacturers, and 415 samples were undergoing analysis and test.

The inspectors and sample collectors of the board, operating throughout the United States, collected 717 samples during the year. A general classification of the articles represented in the collection is as follows:



*Interstate samples collected.*

Class of samples.	Number of samples.
Arsenate of calcium-----	102
Arsenate of lead-----	51
Bordeaux mixture and combinations of Bordeaux mixture with insecticides--	79
Chlorinated lime-----	6
Dips for animals-----	20
Disinfectants, germicides, bactericides-----	83
Fly preparations for animals-----	33
Fish-oil and whale-oil preparations-----	9
Formaldehyde preparations-----	8
Insect preparations, household use-----	52
Insecticide and fungicide preparations, agricultural use-----	92
Kerosene emulsions-----	5
Lice and mite killers-----	32
Lime-sulphur solution and sulphur preparations-----	32
Nicotine preparations-----	6
Paris green-----	24
Pyrethrum and hellebore powders-----	43
Miscellaneous-----	40

**IMPORT SAMPLES.**

During the year 170 official and unofficial import samples of insecticides and fungicides were collected by the various port laboratories of the Bureau of Chemistry for examination and test by the board. Disposition was made of 174 samples; 4 official samples were found adulterated and misbranded, and it was recommended that the consignments be refused entry until correctly labeled. The remaining samples were unofficial, 49 of them being found to be adulterated or misbranded, or both, and in these cases it was recommended that future shipments be detained, while 121 were neither adulterated nor misbranded.

**SPECIAL INVESTIGATIONS.**

The investigation begun several years ago to discover a method of determining stems in insect powder, determine reasonable standards for insect powder, and study the composition of the raw materials and of the finished product, as well as the process of manufacture, has been completed and published as Bulletin 824, United States Department of Agriculture, under the title "Insect Powder." In this bulletin a very complete history is given of the early uses of various species of pyrethrum, of the cultivation and harvesting of insect flowers, of the preparation of insect powder, of the effect of insect powder on insects, of the various adulterants of insect powder that have been used, and of the physiological, microscopic, and chemical methods of detecting adulterants in insect powder. A section on the microscopic examination of insect powder is given, together with a combined chemical and microscopic method for determining the amount of stems in insect powder. Many tables of analyses of authentic samples of insect flowers, insect powders, and stems, are given, on the basis of which the permissible amounts of sand and stems in insect powder have been determined. A résumé is given of previous investigations of the active principles of insect powder, and certain original work published which indicates that the insecticidal activity of pyrethrum is due to a mixture of acids and esters.

A study has been completed by one of the board chemists of the composition and properties of certain arsenates of calcium, and the results have been published in the *Journal of the American Chemical Society*, Vol. XLII, No. 2, February, 1920, under the title, "The Arsenates of Calcium I. Equilibrium in the System Arsenic Pentoxide, Calcium Oxide, Water at 35° (Acid Section)." A second paper on this subject, entitled "Equilibrium in the System Arsenic Pentoxide, Calcium Oxide, Water at 35° (Basic Section)," is in course of preparation and will soon be offered for publication.

Progress has been made in an investigation which has for its purpose the development of an accurate method for determining the total alkaloids in powdered hellebore root and ascertaining reasonable standards for the same, more especially permissible limits for the sand content. It is hoped that the results of this work will be the subject of a future scientific paper.

By reason of the fact that it has been claimed that dry powdered calcium arsenate containing other calcium compounds suffers decomposition on standing in the package, with the result that arsenic in water-soluble forms is produced; a study has been inaugurated to settle this point. Large samples of various manufacturers' dry powdered calcium arsenate containing other compounds have been purchased and stored at Washington, D. C., and Tallulah, La., in various types of containers, and samples from them are being examined from time to time. This investigation has not been completed, but results up to the present time indicate that calcium arsenate containing other calcium compounds does not increase in water-soluble arsenic content with lapse of time.

By reason of the fact that so many of the nicotine soaps and nicotine papers sold on the American market show a much smaller nicotine content than is claimed, a study has been started to determine the rate of loss of nicotine in potash-nicotine and soda-nicotine soaps and in papers impregnated with nicotine. The study was also extended to include the effect of different types of containers on the rate of nicotine loss, the conditions under which loss does and does not occur, and the conditions which will prevent loss. Sufficient data have not yet been accumulated to draw definite conclusions, but the study is being continued.

During the year an investigation was made by the microscopist of the board of a microscopic method of identifying bassia in insecticides and the results have been published in the *Journal of the American Pharmaceutical Association*, Vol. IX, No. 2, February, 1920, under the title "The Microscopical Identification of Mowrah Meal (Bassia) in Insecticides."

The investigations involving studies of many topics relative to the practical use and value of the more important types of fungicides found on the market were continued by the plant pathologists of the board, working in cooperation with the Bureau of Plant Industry. Considerable additional information and more conclusive data of value in connection with the enforcement of the insecticide act have been obtained. In the course of the year considerable information has been gained by the plant pathologists of the board relative to the compatibility of various fungicides and insecticides when used as combined sprays, both from the standpoint of the effect of such combinations on the fungicidal properties and of their in-

jurious effects on vegetation. Publication of these data is anticipated as soon as results from tests now under way are available. In several instances the testing of official samples has developed to the proportions of extensive investigations. This is made necessary in cases involving weak fungicides recommended for the control of diseases which are so erratic in their nature that very extensive and repeated experiments must be made in order to obtain conclusive results. Fungicides which are not wholly inefficient, but which are so weak that they are not satisfactorily effective, require extensive testing to demonstrate their relative value, since material loss results in many cases when such preparations are depended upon as substitutes for the standard fungicides generally recommended for the diseases involved.

The investigation of proprietary insecticides recommended for use against chicken lice and the dog flea and the effects of the various ingredients of such preparations on these insects has been continued by the entomologists of the board. A large series of the common insecticides and many miscellaneous substances have been tested and the effective dilutions of these materials determined. These tests have been summarized and brought together in a bulletin entitled, "The Results of Experiments with Miscellaneous Substances Against Chicken Lice and the Dog Flea."

Extensive field tests with commercial calcium arsenate containing other calcium compounds have been made by the entomologists of the board for the purpose of determining the proper dilution when used as a spray or a dust and its effect on the foliage of fruit trees, shade trees, shrubbery, and truck crops. A study is also being made of the relation between foliage injury and the water-soluble arsenic content, as well as the possibility of reducing such injury by combination with hydrated lime or water-slacked lime. Working in collaboration with the Bureau of Entomology, many data have been obtained on the effect of the soluble arsenic content when such calcium arsenate is used as a dust on cotton plants.

Special work is now being carried on to determine the value of the various proprietary remedies and of many of the common insecticides against the chicken mite, and it is planned to publish a paper on this subject during the coming year.

The experiments to determine the value of the dry substitutes for liquid lime sulphur have been continued and many valuable data have been obtained.

The scientists of the Bureau of Animal Industry branch of the board, working in cooperation with the zoological division of that bureau, have continued investigations relative to the effect of carbon disulphide as a remedy for bots and worms infecting horses, and have extended this investigation to include the effects of carbon tetrachloride and of arsenic for this purpose.

It is further proposed to enter this field more extensively during the next fiscal year in order that more definite knowledge may be obtained regarding the inert or active nature of some of the more commonly used ingredients which enter into the composition of articles recommended by manufacturers as remedies for larval forms of certain flies which infest domestic animals.



## REPORT OF THE FEDERAL HORTICULTURAL BOARD.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
FEDERAL HORTICULTURAL BOARD,  
*Washington, D. C., October 8, 1920.*

SIR: I submit herewith an executive report covering the administration of the plant quarantine act for the fiscal year ended June 30, 1920. The activities of the Federal Horticultural Board are indicated in the list of current quarantine and other restrictive orders appended to this report. These activities have been rather fully recorded in the Service and Regulatory Announcements of the board issued during the year, and these announcements, therefore, constitute an available record in some detail of the work of the board. This annual report is limited to a general discussion of the more important only of these activities.

Respectfully,

C. L. MARLATT,  
*Chairman of Board.*

Hon. E. T. MEREDITH,  
*Secretary of Agriculture.*

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### LINES OF WORK.

The work of the board may be classified as follows:

1. The administration of special appropriations by Congress for the control or extermination of newly established plant enemies, such as the appropriations on account of the pink bollworm of cotton and the potato wart disease and cooperative work in relation to appropriations assigned to the Bureaus of Entomology and Plant Industry for the control of other new plant pests, the quarantine provisions in relation to which are enforced in cooperation with this board under the plant quarantine act.

2. The port inspection service maintained by the board as an essential part of the enforcement of the several foreign quarantines and restrictive orders.

3. The general administration and enforcement of the miscellaneous foreign and domestic quarantine and other restrictive orders listed at the end of this report.

In the discussion of these more important activities, unless otherwise indicated, the record is carried to the date of publication and, therefore, covers substantially the crop season of 1920.

### THE PINK BOLLWORM.

The discovery of the establishment of the pink bollworm in a limited district in Louisiana and its reappearance in southeastern Texas, together with an entire revision of the Texas pink bollworm law

greatly restricting control work, combined to give a new and very serious phase to the pink bollworm situation. For convenience in this report, the status of this problem in Texas and Louisiana will be separately considered.

#### REVIEW OF THE WORK IN TEXAS.

At the time of the preparation of my last report, October 1, 1919, no new infestations or reinfestations of old territory had been determined in Texas following the intensive inspection which had been conducted throughout that year. This was a most encouraging result and indicated the possibility of a successful outcome of the tremendous effort which was being made to control and exterminate this pest. In the latter part of October of that year, however, a few examples of the pink bollworm were found in one of the old infested areas of 1917 in the Trinity Bay district in southeastern Texas, and the later intensive surveys throughout the entire district and surrounding areas in the winter of 1919-20 resulted in the finding of some 43 infested fields scattered practically throughout this district. The infestation, however, was limited in practically every instance to a few plants or to small groups of plants and indicated just such a scattering return of the insect as would have been anticipated.

In the Pecos Valley the intensive field inspections of 1919-20 resulted in the finding of but one infested boll containing a single larva of the pink bollworm.

In the case of the Great Bend area the State had prohibited the growth of cotton in 1919, and this prohibition was made effective except as to one field, the growing cotton in which became infested and was later destroyed under State authority.

Following these discoveries of reinfestation in Texas, the entire areas involved were immediately subjected to intensive clean-up operations similar to those carried out in the winter of 1917-18 and as to the Pecos area in 1918-19, involving the uprooting and burning of all field cotton, the collection and destruction of all scattering bolls, the foreign export of the cotton lint, and the crushing of all seed. These operations were carried out with large expenditure of Federal funds but with the understanding that the State would immediately again declare and enforce under the existing State law a noncotton zone as to the reinfested areas with the purpose of completing the work of extermination of this pest.

The reappearance of the pink bollworm, particularly in the Trinity Bay district, emphasized very strongly the unwisdom of the abandonment of the original program for a two or three years' noncotton zone for the invaded districts of 1917, and pointed clearly to the necessity of immediately resuming this interrupted program if the extermination of the pink bollworm was to be effected. The reinfestations appearing after a one year noncotton zone can be probably explained by the holding over for one year of larvæ which have been buried deeply in the soil or otherwise protected. The possibility of such larval longevity has been fully established by the experts of the board in research work conducted in Hawaii and Mexico.

The departure from the radical program of extermination which had been agreed to between the State and Federal authorities involving noncotton zones for two or three years, or for such period as

might be determined to be necessary to stamp out the pest, was urged by the State authorities in response to the insistent requests of the planters, particularly in the Trinity Bay district, that the growth of cotton should be permitted as a try-out for 1919. In support of this request, it was urged by the planters and later by the State authorities that the cleanup of the winter of 1917-18 of this district had resulted in the nonreappearance of the pink bollworm in the season of 1918, either on volunteer cotton or in any of the fields which had been planted and harvested in defiance of the State regulations and that, therefore, the pest was presumably exterminated or substantially so. In response to these representations and in view of the strong feeling of the planters in the district, making it unlikely that a noncotton zone could be enforced, the board ultimately agreed to this change of policy but with the understanding that if such growth of cotton should result in the reappearance of the pink bollworm in the invaded district, the State would promptly reestablish noncotton zones for all infested areas and maintain them for such period as might be determined to be necessary to complete the eradication of the pest. In this agreement the State authorities and planters of the district joined. To make this action possible, the State pink bollworm act of October 3, 1917, was amended October 10, 1919, so as to permit the growth of cotton under regulation in the noncotton area established under the original act.

With the reappearance, however, of this pest late in 1919 in the Trinity Bay district, the planters of this district, eager to take advantage of the prospective high market value of cotton for the following year, entered strong objection to the proposal of the State to again authorize and enforce a noncotton zone for the district. There followed considerable discussion of the policy to be adopted, namely, whether to permit cotton to be grown under regulation with authority to destroy the plants in the infested fields from time to time if infestation should be determined, or to enforce an immediate and definite noncotton zone for the entire district in consummation of the plans and agreements which had been entered into by the State and planters as a condition for the try-out of the cotton crop for 1919. The former policy was ultimately approved by the State authorities in the belief that it was the only course possible under the powers given by the existing State pink bollworm law.

The department pointed out that the adoption of this policy would mean the practical abandonment of the fight to exterminate the pink bollworm in the United States. This point of view was also strongly emphasized at a conference of official entomologists and inspectors of other cotton States held at Vicksburg in March, and also at a general cotton conference, held at New Orleans in April to discuss the pink bollworm situation and particularly to determine what action the State of Louisiana should take to meet the emergency occasioned by the invasion by this pest of three parishes in that State.

These new developments pointed to the necessity of a Federal quarantine for the protection of other cotton-growing States. A hearing to form the basis of such quarantine was conducted in Washington April 6 and 7 and was largely attended by the officials interested and others of practically all the cotton-producing States of the Nation. As a result of the general discussion of the subject at this



hearing, the governor of Texas, who was present, promised to call a special session of the legislature for the purpose of so revising and supplementing the existing pink bollworm act of that State as to give the needed authority for control work and to provide by State appropriations funds for the enforcement of such special legislation. Such called session of the Texas Legislature was convened at Austin May 20, 1920, and continued for the full legal period of 30 days. The Department of Agriculture, on the invitation of the governor and the legislature, participated in the discussions in relation to the proposed legislation.

For nearly the full legal period of this session the legislature considered a pink bollworm bill which had been drafted by a committee appointed by the legislature for the purpose. This bill if enacted would have prevented all Federal or any other efficient control work in that State on account of the restrictions which it placed on inspection and control activities. At the last moment, however, the bill was discarded and another measure revising the existing act somewhat along the line of the department's recommendation was substituted. Unfortunately, under the 30-day limitation of this called session of the legislature, there was little opportunity to discuss and fully amend and perfect this substitute bill.

As enacted, June 19, 1920, the law omits important powers which were included in the law of 1919, but on the other hand is an improvement on that law in some respects and is perhaps the best legislation which was then obtainable under the conditions which had developed. The main defects in this law from the department's viewpoint are (1) that it does not immediately provide for the enforcement for 1920 of noncotton zones for the invaded districts; (2) that it fails to give authority to establish regulated and noncotton zones in counties bordering on Mexico on the determination of near-by infestation in Mexico and independent of any actual infestation in the counties concerned, as was provided for in the law of 1919; (3) that it limits the destruction of cotton to infested fields and therefore will prevent any regional destruction of cotton which may be necessary for effective work of extermination; and (4) that the establishment of noncotton zones provided for after 1920 is weakened by making it necessary to reestablish such zones yearly. There is also a question as to whether such zones can be established on such regional basis as may be necessary for effective extermination work.

The largest defect in the law from the department's viewpoint is its failure to provide for a noncotton zone for 1920 to put an immediate stop so far as possible to further multiplication of the insect in the invaded Trinity Bay district.

The law, on the other hand, provided for a continuation of all regulated zones for 1920, and also provided for regional clean-up of cotton fields after harvest in such zones. It further provided appropriation of \$100,000 to carry out the act, \$50,000 of which shall be for compensation of farmers for cotton destroyed, or other losses occasioned by the enforcement of the act, and \$50,000 for the administration of the act. An important feature of the law of 1920 is that it declares the pink bollworm to be a public nuisance and a menace to the cotton industry, and that its eradication is a public necessity. This action gives the law a stronger position should its validity be attacked in the courts.

The pink-bollworm developments during the season of 1920, subsequent to the passage of this act, are briefly reviewed in the discussion under the heading "Effective work not possible under new Texas law."

## REVIEW OF THE WORK IN LOUISIANA.

The pink bollworm, previously believed to occur only in limited areas in Texas, was discovered early in February, 1920, to have invaded the parishes of Cameron, Calcasieu, and Jefferson Davis in southwestern Louisiana. After some two months of intensive work extending into April, with a considerable force, no infestation was found in Louisiana outside of these parishes. The most plausible theory of the infestation is that it originated in Cameron Parish through cotton seed presumably obtained for planting from Beaumont, Tex., in 1917, and has spread comparatively recently from Cameron to the two adjacent parishes on the north. There is, however, a possibility of wider infestation in Louisiana and possibly in Texas, due to shipments during the last three years of seed from these Louisiana parishes to various towns in these two States. The records indicate that such seed was shipped to the following towns in Louisiana: Shreveport, Monroe, Bunkie, Alexandria, Broussard, Eunice, and Gretna; and in Texas, to Houston, San Antonio, San Marcos, and Snyder.

There is strong reason to believe that the shipments to the Texas points listed have not resulted in the local establishment of the pink bollworm. Most of this seed, some 25 or 30 carloads, went to Houston, and in the case of these and all of the other shipments into Texas the seed was promptly milled and thus in large measure safeguarded. Furthermore, all of the places listed in Texas except Snyder, on account of their relationship to seed imported from Mexico in 1916, have been under intensive scouting for the last three years and no trace of the pink bollworm has been detected. In the case of Snyder, but a single carload of seed was received from Louisiana and this was in 1917 and the seed was immediately crushed.

A thorough field inspection surrounding the points in Texas and Louisiana to which had been shipped seed from the infested parishes in Louisiana, begun in February, 1920, with respect to the crop of 1919, has been continued. No infestation of the pink bollworm at any of these points has been reported to date, October 1.<sup>1</sup>

Following an interstate conference called at New Orleans March 5, by Gov. Pleasant, of Louisiana, the State of Louisiana promptly enacted necessary legislation and established noncotton zones for all the infested districts and regulated areas for all the points within the State to which seed or cotton had moved from these infested districts. Provision was also made for a State fund of \$250,000 for the enforcement of such noncotton and regulated areas and for the reimbursement of planters in the noncotton areas for losses which they might sustain through the growth of crops less profitable than cotton.

The working out of this Louisiana legislation, which became effective early in July, 1920, has been most satisfactory. The prohibition of growth of cotton in the invaded parishes has been effi-

<sup>1</sup> Subsequent to the preparation of this report, the board has been advised of the finding of infestation in a field alongside the Louisiana Cotton Oil Co., in Bossier Parish, immediately across the Red River from Shreveport.

ciently maintained with full cooperation on the part of the planters, and the restrictions on cotton movement with respect to the points in the State which had received seed from these parishes in the two or three years prior to the discovery of the pink bollworm have been fully carried out.

In the case of both Louisiana and Texas, legislative provision is specifically made for cooperation on the part of the United States Department of Agriculture in the enforcement of quarantine and other control operations.

#### FEDERAL QUARANTINE OF TEXAS AND LOUISIANA.

As long as the pink bollworm was believed to be confined to fairly limited districts within the State of Texas and these districts were being adequately controlled by Federal and State authorities working in cooperation, there was no vital need for the enforcement of a Federal quarantine covering interstate movement of products out of Texas. As already indicated, the altered outlook for 1920 pointed strongly to the need of a Federal quarantine of Texas and Louisiana to prevent the spread of the pest to other cotton-growing States. The basis for such quarantine had already been established by the public hearing, conducted in Washington on April 6 and 7. Following this hearing, and in view of the fact that the Federal quarantine would probably modify or replace the quarantine action which had been taken or which was being contemplated by other cotton-growing States with respect to Louisiana and Texas, it seemed desirable prior to the issuance of a Federal quarantine to call a conference of all the cotton-growing States to consider and pass upon the proposed Federal quarantine. Such conference was called at Washington July 14, 1920, and was attended by official and other representatives of eight States. The preliminary draft of the Federal action was carefully considered at this conference and a general agreement was reached to harmonize the State action with the Federal action or to permit the Federal action to replace State quarantines.

The Federal quarantine of Texas and Louisiana on account of the pink bollworm was promulgated July 21, effective August 1, 1920, and was so drawn as to apply in its restrictions on the movement of cotton and other articles to the areas known to be infested or suspected of possible infestation in the two States concerned, but this limitation was conditioned upon the enforcement by these States of effective control measures with respect to the crops produced in the restricted districts.

#### EFFECTIVE WORK NOT POSSIBLE UNDER NEW TEXAS LAW.

The enforcement of the Federal quarantine under the new Texas law has been far from satisfactory and has still further fully demonstrated the inadequacy of any control system looking to extermination other than that of the complete elimination of the growth of cotton in invaded districts. As was to have been expected, scattering infestation of cotton in the Trinity Bay district began to develop in the late summer of 1920, and has now, October 1, been rather widely determined throughout that district. The pink bollworm act of 1920 provides for the prompt destruction of the



cotton in fields determined to be infested with the pink bollworm with State compensation for the crop destroyed. In spite of this provision for compensation, the opposition of planters to necessary extensions of the quarantine was immediate, and by injunction a serious check was put upon State and Federal control work. This injunction even went so far as to forbid Federal control of interstate movement but this phase has since been removed as a result of representations as to the illegality of such action made to the Texas court by direction of the Attorney General of the United States.

This outcome in Texas would seem to indicate that the State is unable to adequately cope with the local legal situation and it may become necessary to consider the extension of the existing Federal quarantine to cover the entire State as the only means of protecting the surrounding States from the movement of cotton or other materials from Texas capable of carrying the pink bollworm.

It is greatly to be regretted that the plan of extermination by the establishment of noncotton zones in infested areas, which began with such promise of success with the crop season of 1918, should have had any break in its operations. Apparently under existing conditions in Texas there seems little likelihood that such noncotton zones can be adequately enforced in the future. The failure of the authorities and citizens of Texas to make possible such enforcement must ultimately mean the loss of the opportunity which undoubtedly existed at the outset to exterminate in Texas and in the United States what is believed to be the most important of all cotton pests. The department's efforts to secure adequate cooperation by the State of Texas to this end have been unremitting.

A full record of these efforts and the action of the department in relation to the pink bollworm work in Texas is given in the Service and Regulatory Announcements of this Board for 1920.

So far as is now known, the pink bollworm infestation in Texas is confined to the southeastern district surrounding Trinity Bay. No reappearance of the pink bollworm has been reported this year from any of the other areas, namely, the Hearne area and the Pecos district, nor from any new areas in Texas. The Great Bend area and a limited area at Hearne have been maintained as noncotton zones. Eradication may still be possible, therefore, with adequate State legislation and thorough work in connection with noncotton zones.

#### FEDERAL AND STATE APPROPRIATIONS FOR PINK BOLLWORM WORK.

Under the belief that the work of the extermination of the pink bollworm was well advanced and that very little expensive cleaning of fields would be necessary for 1920-21, the fund for control work, which had been \$400,000 for the years 1919-20, had been reduced in the department estimates to \$225,000. This estimate was still further reduced in the bill as presented to the House by the Agricultural Committee to \$125,000.

To meet the need for a large increase in control work resulting from the appearance of the pink bollworm in certain parishes of Louisiana, and its reappearance in Texas, Congress was asked to increase the appropriation for the pink-bollworm control by \$300,000. This increase was carried in the bill as it passed the Senate, but in the conference committee the increase was reduced to \$200,000. This gives

a fund for the control and eradication of the pink bollworm for the fiscal year 1921 of \$325,000. This is exclusive of the border control appropriation of \$148,560, a fund of \$10,000 for surveys in Mexico near the border of the United States, and an item of \$5,000 for investigation of the pink bollworm as a basis for control measures. The total appropriation for pink-bollworm work is therefore \$488,560. In addition, there is available for pink-bollworm work the appropriation by the Texas Legislature of \$100,000 and by the Louisiana Legislature of \$250,000.

#### RESEARCH WORK IN RELATION TO PINK BOLLWORM.

**LAGUNA STATION CLOSED.**—The research station which has been maintained in the Laguna, Mexico, for the past two years was closed this year, research work which could be conveniently done at this time having been substantially completed. A report will soon be issued giving the results of the two years' study of the pink bollworm in Mexico. The damage to cotton in this district in Mexico in 1919 averaged about 20 per cent of the crop. Of special interest is the fact that fumigation tests have shown that infested seed can be satisfactorily disinfected with carbon bisulphide, but that hydrocyanic acid gas at the ordinary atmospheric pressure has not sufficient penetrating powers to be effective to a greater depth than a few inches. The attempt to control the insect in the field with arsenical poisons has yielded only negative results.

The larvæ of the pink bollworm have been found to be very resistant to water and have survived 48 hours' immersion, whereas larvæ in dry bolls have survived a period of seven or eight days. This probably gives an explanation of one of the means of spread of larvæ, especially in a district like that of the Great Bend of the Rio Grande by water carriage in bolls or parts of the cotton plant which may be caught up by flood waters.

**STUDY OF OTHER HOST PLANTS THAN COTTON.**—A very careful survey has been conducted of the malvaceous plants along the Rio Grande and elsewhere in Texas to determine the possibility of their serving as hosts for the pink bollworm. This included not only wild plants, but also such cultivated plants as species of hibiscus and hollyhock and garden plantings of okra. In no case has the pink bollworm been found to infest any of these plants. In Texas, therefore, it so far has confined itself strictly to cotton, and this is of very great importance in connection with the efforts to exterminate the insect by establishment of noncotton areas. That the insect will feed at least on okra has, however, been shown by the experience in Egypt, and this has also proved to be the case in Mexico, and therefore this and possibly other related plants must be taken into consideration in control work.

#### BORDER QUARANTINE SERVICE.

The Texas border inspection quarantine service, which has heretofore been under the general direction of Mr. R. Kent Beattie, has recently been transferred to the direction of Mr. E. R. Sasscer, and to this department has been added the general administration of all the port inspection service being conducted under the Federal plant-quarantine act, namely, the inspection offices and forces at New York, Boston, San Francisco, Seattle, and New Orleans.

In the enforcement of the Texas border inspection and quarantine service a total of 15,962 freight cars and 14,846 vehicles have been inspected and certified for entry into the United States. The car and vehicle fumigation houses referred to in previous reports were completed and put into operation on October 1, 1919, and since that date 7,772 cars have been disinfected in these houses with hydrocyanic-acid gas. The Congress, in appropriating funds for the purchase of chemicals and for labor incident to the proper fumigation of cars crossing the border, made the proviso that:

Any moneys received in payment for charges fixed by the Secretary of Agriculture on account of such cleaning and disinfection at plants constructed therefor out of any appropriation made on account of the pink bollworm of cotton to be covered into the Treasury as miscellaneous receipts.

Accordingly an initial charge of \$5 per car was made, but owing to a reduction in the cost of chemicals it was possible, on February 1, 1920, to reduce the cost per car to \$4. A fee of 50 cents is collected for each buggy, wagon, or automobile fumigated at Del Rio, Tex. During the nine months of operation \$34,381 were collected and turned into the Treasury as miscellaneous receipts.

It has been necessary to considerably enlarge this border service during the year. It now includes, in addition to the ports from El Paso eastward, Nogales, Ariz., in connection with the extension of the border traffic regulations to the State of Sonora. Since establishing this service at Nogales, on January 20, 1920, 2,725 cars have been inspected and certified for entry at that port. At present no car-fumigation facilities are available at Nogales, and it will probably be necessary to provide a large car-fumigation house at that point in the near future.

The arrival of many cars fouled with cotton seed at Juarez, Mexico, opposite El Paso, and the finding of much of this seed to be more or less infested with living pink bollworms, has necessitated a considerable enlargement of the fumigation facilities at the port of El Paso. The construction of a 15-car fumigation house at this port was begun in June, 1920, to take the place of the inadequate 1-car house which was being used to fumigate the small percentage of cars which up to that time had crossed at El Paso. As soon as the new house is completed all cars crossing at this point from Mexico into the United States will be subjected to disinfection, as is now the practice at other Texas-Mexico border ports.

The extension of this border service to include Mexican corn is discussed below. This extension has resulted in the erection by private concerns of sterilization plants at Piedras Negras and El Paso to meet the requirements of sterilization by heat. All such sterilization takes place under the supervision of inspectors of this board. Similar disinfecting plants may later be established at Brownsville, Del Rio, and perhaps other points on the border. A similar plant is under consideration at Los Angeles, Calif., for the sterilization of Mexican corn reaching that point by direct water route from Mexico.

In order to further prevent the entry of the pink bollworm and other insects subject to quarantine, inspectors have been placed at the footbridge of all of the important ports to work in cooperation with the customs officials. The wisdom of this move was soon



apparent, since 57 living larvæ of the pink bollworm were found in cotton seed and cotton bolls in suit cases of passengers. This infested seed was in possession of immigrants en route to cotton fields, where they were to be employed as laborers. Had these insects escaped the notice of the board's inspectors, they would have doubtless become established in American cotton fields. The extent of this danger may be indicated by the fact that some 15,000 laborers annually migrate from Mexico to Texas and Arizona for cotton picking. Avocados were frequently intercepted and during the month of May fully 50 per cent of the avocados reported to have been grown in the State of Michoacan were found to be infested with a weevil, which is apparently much more injurious than the avocado weevil, which was responsible for Quarantine No. 12. Incidentally it was proposed by the owner of one of the interceptions to take the infested avocados to California for the purpose of planting the seed in his avocado grove. Although this phase of the work was conducted only about six months of the year, some 1,018 interceptions have been made of contraband material, including cotton seed, seed cotton, unmanufactured cotton lint, sugar cane, peaches, sweet limes, mangoes, oranges, sweet potatoes, avocados, and various plants. Frequent attempts have been made to smuggle quarantined fruits as, for example, wrapping meat around avocados or inclosing them in a loaf of bread.

#### RESTRICTIONS ON ENTRY OF MEXICAN CORN ON ACCOUNT OF THE PINK BOLLWORM.

Mexican corn in considerable quantities began to be offered for entry into the United States early in January of this year. Some of this corn was known to have originated in regions infested with the pink bollworm, either near the border or in the interior of Mexico, and examinations indicated that such corn contained more or less cotton seed as well as seeds of other crops, such as beans, coffee, pumpkins, pecans, etc., indicating great carelessness in handling it, probably in connection with bins or with carts or other conveyors more or less fouled with cotton seed and the other products enumerated. Inasmuch as it proved to be thoroughly impracticable to inspect and free such corn from cotton seed or to disinfect it at the border with the means available, it was found desirable to provide by a special quarantine for suitable control of such material.

The quarantine as subsequently issued provides for the entry of Mexican corn when so ground or sterilized by heat as to eliminate all risk of carriage of cotton seed or pink bollworm larvæ. The feasibility of sterilization already had been demonstrated and was a working condition at San Francisco and Seattle with respect to corn imported from the Orient, chiefly Manchuria, for local use on the Pacific coast.

Pending the issuance of this quarantine the entry of Mexican corn was prohibited under authority granted by Congress to regulate the entry of all products from Mexico, for the purpose of excluding cotton and cotton seed. This quarantine does not apply to the State of Lower California, Mexico.

## STATE OF SONORA INCLUDED UNDER REGULATIONS GOVERNING ENTRY OF PRODUCTS FROM MEXICO.

The States of Sonora and Lower California, Mexico, had not hitherto been brought under the regulations of June 23, 1917, governing the entry into the United States at border points of products from Mexico. Information indicating the possible occurrence of the pink bollworm on the west coast of Mexico made it necessary to bring the State of Sonora under the control of these regulations. This was accomplished by an amendment issued January 29, 1920. These regulations now cover all of the border ports of Mexico with the exception of those of Lower California.

## ENTRY OF HAWAIIAN AND PORTO RICAN COTTON, COTTON SEED, AND COTTONSEED PRODUCTS, RESTRICTED.

In the latter part of 1919 a request came to the Federal Horticultural Board for a permit for the entry into the United States from Porto Rico of a considerable quantity of cotton seed for milling at oil mills in the Southern States. Hitherto there had been little or no movement of such seed from Porto Rico to the mainland owing to the fact that this seed under the Spanish régime and later had found its market in Europe. At that time there was no quarantine under which the proposed shipment of seed from Porto Rico to the mainland could have been prevented, but on the request of this board the shipment was withheld until an examination of the cotton situation of the island with respect to plant diseases and insect pests could be made. An investigation which has since been carried out under the direction of this board indicates the undesirability of permitting raw cotton seed or cotton lint containing seed coming to the United States from Porto Rico. Important among these reasons is the existence in Porto Rico, as well as in most of the West Indies, of a cotton blister mite (*Eriophyes gossypii* Banks), which has been the occasion of a good deal of loss to the cotton crop of these islands. This mite is not known to occur in the United States, and its entry into our cotton producing States would amount to a new tax on cotton production. For the particular purpose of excluding this mite a quarantine (No. 47) has been issued against Porto Rican cotton, cotton seed, and cottonseed products. It is known, however, that there is also in Porto Rico a cotton-boll disease, which may be even more dangerous to the cotton crop of this country than the blister mite and which might also gain entrance through the importation of cotton seed. The enforcement of the quarantine will make it necessary for the cotton seed produced in the island either to be exported to foreign countries or else to be milled or otherwise utilized on the island.

To avoid the multiplicity of quarantines the similar quarantines (Nos. 9 and 23, revised) already issued with respect to Hawaiian cotton have been incorporated in Quarantine No. 47, so that the movement of all cotton and cottonseed products from Hawaii and Porto Rico will be governed by one order and series of regulations.

## THE EUROPEAN CORN BORER.

## PRESENT STATUS OF PEST IN UNITED STATES AND CANADA.

The European corn borer was rather fully considered in the annual report of this board for 1919. Its status in the United States remain substantially unchanged during the season of 1920. The additions to the infested territory have been limited to the inclusion of some 150 townships in Massachusetts, New Hampshire, and in eastern and western New York, merely extending locally the range of last year. No new areas of infestation have been found in these States, nor has any infestation by this insect been located in the Mississippi Valley in connection with the surveys following up the movement of imported broom corn to various broom factories in the Middle West. The insect has not reappeared in Erie County, Pa., where it was determined last year, and may possibly have been exterminated at that point.

The important development of the corn borer situation during the year has been the discovery of two wide infestations in southern Ontario, Canada, bordering Lake Erie, one having an extent of perhaps 50 miles near Niagara, and the other of nearly 100 miles centering at St. Thomas, Ontario. The origin of the insect in Ontario seems to have been in connection with a broom factory formerly operated at St. Thomas, which in 1909 used enormous quantities of foreign broom corn and was at that time the largest broom factory in Canada. In this Canadian area of infestation corn is grown on a commercial scale, chiefly of the flint varieties, which in the United States have proved especially susceptible to the attacks of the insect. While the insect was widely distributed in the Province of Ontario, field damage of considerable amount seemed to be limited to the center of the larger area near the town of St. Thomas. In this area certain fields exhibited an amount of damage greater than that shown in any of the New York fields, not however large as compared with other important corn enemies. For example, the actual grain loss due to the borers feeding in the ears alone was estimated by the Canadian authorities as between 3 and 4 per cent in the worst infested field, and about one-half of that percentage in the next worst infested field, the latter field of the dent variety.

## REVISION OF THE DOMESTIC CORN BORER QUARANTINE.

A new quarantine to prevent interstate shipment of carriers of the corn borer was promulgated by the Secretary of Agriculture, effective March 29, 1920, against the States of Massachusetts, New Hampshire, New York, and Pennsylvania. The quarantine applies only to such portions of those States as are now or may later become actually infested, although authority is reserved to extend at any time the areas officially designated as infested, to cover any extensions of spread. No restrictions are placed on shipments from points in the quarantined States outside of the infested areas.

The articles specifically covered in the quarantine are corn and broom corn, including all parts of the stalk, celery, green beans in the pod, beets with tops, spinach, rhubarb, oat and rye straw as such or when used as packing, cut flowers or entire plants of chrysanthemums, aster, cosmos, zinnia, and hollyhock, and cut flowers or entire plants of gladiolus and dahlia, except the bulbs without stems. The restric-



tions do not apply to shelled corn and clean seed of broom corn, nor to other articles after they have been manufactured or processed in such a way as to eliminate risk of carrying the corn borer.

The quarantine of 1920 revises and supersedes the original quarantine of Massachusetts on account of this insect and was necessitated by the discovery of the new important areas in New York in the fall of 1918 and the rather rapid increase of information as to distribution, together with the discovery of many additional food plants. The postponement of this revision until 1920 was occasioned by the fact that the territory invaded by this insect was so inadequately determined as to make any quarantine comparatively valueless. As a preliminary measure of control, however, the States of New York and Massachusetts agreed through their representatives to establish State quarantines covering the known invaded districts, so that there should be no interstate movement of infested products from such districts and such quarantine orders were issued by the commissioners of agriculture of New York and Massachusetts.

The enforcement of the Federal quarantine, in cooperation with corresponding State quarantines which were promptly thereafter issued, has been the chief and about the only effective control possible of this new pest by preventing or limiting its further spread through the agency of the movement of infested farm and garden products. The wide extent of this pest in Massachusetts and New York has prevented, both on the ground of expense and uncertain efficiency, general farm control over the entire regions infested, under Federal and State funds. Limited control with such funds has been and may be practicable and desirable in the future where the insect is found in considerable concentration, but in general such farm control must be assumed by the farmers concerned.

#### ALL FOREIGN COUNTRIES QUARANTINED ON ACCOUNT OF THE EUROPEAN CORN BORER.

The further entry of broom corn, Indian corn, and related plants, has been either prohibited or restricted in the quarantine promulgated February 21, 1920, for the purpose of preventing the further entry into the United States of this corn borer or of other dangerous insects or of plant diseases through the agency of stalks or other portions of these plants.

Broom corn for manufacturing purposes may be imported hereafter only under permit and when its condition is such that it can be satisfactorily disinfected at port of entry. Indian corn and certain related plants from all foreign countries are denied entry into the United States in the raw or unmanufactured state, except sorghum hay from Canada, and the shelled or thrashed grain from any country, of the plants included in the quarantine. The quarantine applies also to such plants related to corn as sweet sorghums, grain sorghums, sugar cane, Sudan grass, Johnson grass, pearl millet, Napier grass, teosinte, and Job's tears.

The necessity for this quarantine was demonstrated early in the year by the discovery of living larvæ of the corn borer in some 97 bales of broom corn shipped from Italy to New York, the first considerable shipment of foreign broom corn since the war period. This finding, in connection with the association of earlier importations with the infested areas in this country, would seem to defi-

nately determine that the European corn borer originally reached this country through the medium of such imported broom corn.

This quarantine was later amended (July 31, 1920) to include under its provision manufactured brooms and also the provision that the raw broom corn should be so selected in the country of export as to be free from visible evidence of infestation. The necessity for including brooms was determined as a result of an examination of a considerable importation of large Italian stable brooms. These proved to be stuffed with a considerable quantity of the actual stems of broom corn and could thus be a means of conveying the insect equally readily with unmanufactured material. At the present time, therefore, the requirement of disinfection as a condition of entry applies to both the manufactured and raw product. The only disinfection which has proven effective is by steam cooking, a process which apparently does not injure the value of the broom corn either in the raw state or as manufactured.

#### EXTENSION OF JAPANESE BEETLE QUARANTINE.

The Federal quarantine on account of the Japanese beetle has been twice revised during the year, namely, on April 1 and October 1, 1920. The first of these revisions had relation to the inclusion of a slight increase of the invaded territory in New Jersey and a broadening of the quarantine to cover, in addition to green or sugar corn, a large list of truck crops and other articles which might act as possible carriers of the pest.

The second revision of the quarantine (October 1, 1920) was made to take into account a further extension of this insect in New Jersey and also its extension across the river from the New Jersey territory into the border counties of Philadelphia and Bucks, in Pennsylvania. This quarantine is being enforced in cooperation with the Bureau of Entomology of this department and with the States concerned. It provides for the movement of all the articles brought under restriction under inspection and certification.

#### THE POTATO WART.

##### PRESENT DISTRIBUTION OF THE DISEASE.

The potato wart disease was last year reported as occurring in two areas in Pennsylvania, one in the eastern and the other in the southwestern part of the State, and in an area in West Virginia. The surveys of 1920 have extended these areas somewhat and the disease has been determined as occurring in western Maryland. Practically all of these occurrences are in mining regions and probably had a similar origin from foreign potatoes imported in the winter of 1911-12.

The survey planned for 1920 included a program of intensive search in mining regions in these States and also garden inspections in selected localities in settlements of a foreign character approximating in method of living and garden cultures those obtaining in mining districts. These surveys have been negative other than as to the mining districts in the States named. They were intensively conducted at a number of points in New England in centers of foreign population, and also in New York, New Jersey, Ohio, Michigan, Indiana, Illinois and Wisconsin, including coal fields in Indiana and Illinois.



The infestation as now determined in southwestern and western Pennsylvania includes points in Cambria, Clearfield, Center, Armstrong, and Huntingdon counties. The work of this year, therefore, has materially extended the infestation in this part of the State. The infested area in eastern Pennsylvania remains substantially the same as reported last year.

The intensive search made in the coal mining sections of northern and southern West Virginia did not result in the discovery of any new areas of infestation in that State. The old area in the immediate vicinity of Thomas, W. Va., was, however, slightly extended by the discovery of the disease in two neighboring villages.

The wart disease was discovered in Maryland in eastern Allegany County in three villages in the neighborhood of Frostburg. But a single infested garden was found in each village, but on account of the lateness of the season a full determination of the infestation could not be made. Furthermore, the principal potato grown in the district is the Cobbler, which is immune to the disease. There is reason to believe therefore that the disease may be more extensively present in this section than is now known. Its discovery in Allegany County, Md., is of special importance since the growing of seed potatoes is becoming a considerable undertaking in that immediate locality.

Unlike the infestation in eastern Pennsylvania, the infested localities in the soft coal regions in western Pennsylvania, Maryland, and West Virginia are apparently scattered, the disease occurring in single gardens or in a small number of gardens in each village.

#### RESEARCH WORK ON POTATO WART.

**DETERMINATION OF IMMUNE VARIETIES OF POTATOES.**—The research work in connection with the potato wart, begun in 1919, has been continued but on a more extensive scale in cooperation with the state colleges and departments of agriculture of Pennsylvania and West Virginia. Up to date some 78 named American varieties of potatoes have been tested and of these 27 have been found to be immune to the wart disease. In addition, a great many seedlings have been tested and also a considerable number of foreign varieties, English, Scotch, and German, many of which also appear to be immune varieties. It is worthy of note that all the varieties found to be immune in the tests of 1919 have retained their immunity through the second year of testing. Their reaction to the wart disease has also been the same in Pennsylvania and West Virginia.

Some of the imported immune varieties show considerable promise for general distribution in this country and stocks of these will be increased next year. The number of known American varieties immune to the wart disease now covers the range from early to late potatoes and includes several of the best commercial varieties. These stocks likewise will be much increased in 1921.

**DISINFECTION OF SOIL.**—Considerable progress has been made in the determination of the feasibility of disinfecting soil known to be invaded by the disease. Soil which was thus disinfected by steam and by chemicals and other means in 1919 was planted to potatoes susceptible to the disease this season and the results, while not thoroughly effective in controlling the disease, have been very promis-



ing and large yields of potatoes have been obtained on soil thus treated. The best results were obtained with steamed soil and with soil treated with Bordeaux mixture and with mercuric chloride. Further tests of such soil treatments are in progress.

**MISCELLANEOUS RESEARCH NOTES.**—It has been shown that the soils in the infested gardens are commonly very acid, and that infections are less severe where the soil reaction approaches neutrality. The organism has been shown also to be an acid producer in the tissues it infects. These facts indicate the desirability of more extensive studies on the relation of soil reaction to distribution of and infection by this organism, and such studies are projected for the coming winter. In general it is planned to study more intensively than heretofore the soil environment and the meteorological characteristics of the infested areas with a view to correlating with these the present and possible distribution of the wart disease in the United States.

The majority of the tomato varieties tested for reaction to the wart disease became infected and it seems probable that the tomato may not show the varietal differences in susceptibility and resistance so characteristic of the potato. While the tomato is not affected in yield by this disease, its service as an additional host makes it a factor to be considered seriously in a potato quarantine program. No new hosts have been definitely determined for this organism, but several solanaceous plants are under suspicion and a number of new species will be tested this winter.

In cooperation with the department of botany of Pennsylvania State College a method has been worked out of isolating wart sporangia from the soil, either singly or in quantity. This method will be of great service in further investigations on the germination, thermal, and toxic relations, etc., of the organism.

#### COOPERATION WITH OTHER BUREAUS IN ADMINISTRATION OF PLANT QUARANTINES

In addition to the corn borer, Japanese beetle, and the gipsy moth and brown-tail moth quarantines carried out in cooperation with the Bureau of Entomology, the board is cooperating with the Bureau of Plant Industry in the enforcement of the quarantine on account of the black stem rust of wheat and the quarantine on account of the white pine blister rust. The board is also cooperating in the enforcement of the State quarantines on account of the flag smut and take-all diseases of wheat, as well as enforcing the foreign quarantines promulgated by the board on account of these diseases.

#### COTTON, COTTON WASTE, COTTON BAGGING, AND COTTONSEED PRODUCTS IMPORTATIONS.

The restrictions on the entry of cotton, cotton waste, burlap, cotton seed, seed cotton, and cottonseed products for the purpose of excluding the pink bollworm and other pests is a part of the continuing work of the board and represents a large element of the port inspection service at the ports of entry where such importations are authorized. These ports are Boston, New York, San Francisco, and Seattle. No restrictions are placed on the entry of cotton from Lower California, Mexico, under a cooperative arrangement with the authorities of that State, except that it must come in under permit through the port of Calexico. By special arrangement,

however, a lot of 61 bales of cotton grown in Lower California was permitted entry through Yuma, Ariz. The importations shown in the accompanying tables are for the fiscal year ending June 30, 1920.

The importations of lint cotton of this year much exceed those of any fiscal year since the effective date of the cotton regulations, July 1, 1915. The following table, giving the imports for each of the years since 1915, is introduced for the purpose of comparison:

	Bales.		Bales.
1915-16.....	316,260	1918-19.....	179,537
1916-17.....	216,337	1919-20.....	595,765
1917-18.....	195,723		

It will be noted that the figures for the fiscal year 1919-20 exceed by nearly 280,000 bales those for 1915-16, the next highest year, and that this excess of 280,000 bales is greater than the entire amount imported during each of the next three fiscal years, the excess over last year's importations being over 400,000 bales. As a natural consequence of the cessation of war activities and the reestablishment of business there has been a marked increase in the amount of Egyptian cotton imported, the importations of this year exceeding those for the last fiscal year by 273,697 bales. To these same reasons may doubtless be attributed the increase of Indian cotton, namely, 14,348 bales over that entered last year.

There is also a marked increase in the amount of cotton entered from other countries. Brazil exceeds her shipments of last year by 5,885; China, by 47,779; Mexico, by 10,614; and Peru, by 59,939.

Though the cotton waste imported this year shows an increase of 1,518 bales over last year's entries, it should be noted that the importations of last year included 13,936 bales of American cotton waste returned from Canada, where it had been shipped for war purposes, while this year only 58 bales of American cotton waste were returned.

In the amount entered burlap shows an amazing increase over last year, being nearly seven times as great. Last year 24,236 bales were entered. This year 163,383 bales were imported, an increase of practically 140,000 bales. The restricted burlap totaled 12,498 bales, of which 3,372 were fumigated at the various fumigation plants and 9,126 bales converted into paper. The burlap referred to as being converted into paper was released from fumigation under the condition that it should be immediately so converted and at factories within a short distance of the port of entry, such movement and conversion to be throughout under the control and supervision of the board.

The following tables indicate relatively the quantities of cotton, cotton waste, burlap, and cotton seed and cottonseed products imported during the fiscal year. They further indicate the country of origin and the ports of entry into the United States and will be useful for comparison with similar tables published in former annual reports.

*Ginned cotton, by ports of entry and country of origin, 1919-20.*

[Bales.]

Country.	Boston.	Calex-ico.	De-troit.	Fall River.	New Orleans.	New York.	Niagara Falls.	Philadel-phia.	San Francisco.	Se-attle.	Yuma.	Total.
Argentina.....						98						98
Brazil.....						5,885						5,885
China.....	207					56,163			763	744		57,877
Dominican Re-public.....						83						83
Ecuador.....						20						20
Egypt.....	328,132					7,961						336,093
Haiti.....						11,560						11,560
India.....	2,295					15,961						18,256
Mexico.....		59,285				6,059					61	65,405
Nicaragua.....						36						36
Peru.....	11,000					84,730						95,730
Turks Island.....						14						14
United States.....	2,207		2	140	574	291	1,257	21				4,492
Venezuela.....						173						173
Unknown.....	1					42						43
Total.....	343,842	59,285	2	140	574	189,076	1,257	21	763	744	2 61	595,765

<sup>1</sup> Includes 10,038 bales of unginned cotton from Imperial Valley, Lower California, Mexico.<sup>2</sup> Unginned from Imperial Valley, Lower California, Mexico.*Cotton waste, by country of origin and port of entry, 1919-20.*

[All figures represent running bales.]

Country.	Boston.	Gal-veston.	New York.	Phila-delphia.	St. Albans.	San Francisco.	Seattle.	Ta-coma.	Total.
Canada.....	762		100	74	212				1,148
China.....						4	150	150	304
England.....	832	54	837	2,759					4,482
France.....			1,525						1,525
Holland.....			59	50					109
Italy.....			4,389						4,389
Japan.....	589		3,190			35	61		3,875
Mexico.....			120						120
Scotland.....			45						45
Spain.....			853						853
Straits Settlement.....							70		70
United States.....	44		14						58
Total.....	2,227	54	11,132	2,883	212	39	281	150	16,978

*Bagging, by country of origin and port of entry, 1919-20.*

[All figures represent running bales.]

Country.	Balti-more.	Boston.	New Orleans.	New York.	Phila-delphia.	Port Huron.	Provi-dence.	Seattle.	Total.
Belgium.....	197	2,832		7,788	602				11,419
Canada.....		12,013	100	458		565			13,136
Canal Zone.....				172					172
Cuba.....				3					3
Denmark.....				1,713	308				2,021
England.....	2,374	17,038	3,762	27,855	19,516		149		70,694
France.....		617		25,436	666				26,719
Germany.....				274					274
Holland.....	2,438	272		14,891	1,004				18,605
Italy.....		8		1,537					1,545
Japan.....								2,826	2,826
Newfoundland.....				3					3
Portugal.....				164					164
Scotland.....		3,821		6,765	164				10,750
Spain.....				4,581					4,581
Switzerland.....				471					471
Total.....	5,009	36,601	3,862	92,111	22,260	565	149	2,826	163,383



*Cotton seed and cottonseed products, 1919-20.*

Port.	Cotton seed.	Cotton-seed cake.	Cotton-seed meal.	Cotton-seed oil.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Gallons.</i>
Calexico.....	23,952			
Eagle Pass.....		14,784		469,000
Laredo.....		868		24,762
New York.....			1,202	
San Francisco.....		2,724		
Seattle.....		418		
<b>Total.....</b>	<b>23,952</b>	<b>18,794</b>	<b>1,202</b>	<b>493,762</b>

**NURSERY STOCK, PLANT AND SEED IMPORTATIONS.**

Quarantine 37, which applies new and important prohibitions and restrictions on the entry into the United States of nursery stock, plants, and seeds, became effective June 1, 1919. The fiscal year ending June 30, 1920, therefore, represents the first year's record of the enforcement of this quarantine. Under this quarantine three classes of entry are provided for.

1. Entry of fruits, vegetables, cereals, and other plant products which are capable of propagation, intended for medicinal, food, or manufacturing purposes; and field, vegetable, and flower seeds. These classes are permitted entry without permit or other restrictions, and therefore no record has been kept by the board of such importations.

2. Nursery stock and other plants and seeds for which permit is required but of which unlimited commercial importation is permitted. This class is restricted to five categories, chiefly certain bulbs, fruit stocks and rose stocks and seeds of trees and ornamental shrubs for propagation.

3. Entry of any of the prohibited classes of nursery stock under special permits for the purpose of keeping the country supplied with new varieties and necessary propagating stock; in other words, for the establishment of reproduction enterprises in this country so that as soon as possible this country shall be independent of all foreign supplies of that character.

**IMPORTATIONS OF NURSERY STOCK AND OTHER PLANTS OF WHICH FREE COMMERCIAL ENTRY IS PERMITTED.**

The following three tables record the importations of nursery stock and other plants and seeds of which unlimited commercial importation under regulation 3 is provided for in the quarantine under permit. The records of importations given in these tables are based on the notice of arrival viséed by the customs officers as is required under the quarantine, and therefore represent probably as accurate information of the plants thus imported as is obtainable.

The first table gives a record of the importations of fruit stocks and rose stocks, together with country of origin. It is interesting to note that the importation of fruit stocks this year represents a total of 7,856,620 plants and compares therefore favorably with the total importations recorded in the annual report for the previous fiscal year, and would seem to dispose of the contention frequently made that the unavailability of foreign fruit stocks during the last fiscal

year was due in any part to the refusal of the foreign growers to sell to American importers in retaliation for Quarantine 37. It is, however, a well-known fact that during the past two years, owing to post-war conditions and failure of the fruit crop in France, the stock of seeds for the production of seedlings was very low, and whatever shortage has arisen has been due to these two causes. The number of rose stocks imported this year is about the same as for last year.

The second table indicates the number of bulbs imported under regulation 3 of Quarantine 37.

The third table is interesting as showing the general classes of tree seeds and ornamental shrubs imported during the past fiscal year and also the countries of origin.

*Country of origin and nature of importations under regulation 3, Quarantine 37.*

#### FRUIT AND ROSE STOCKS.

[Figures indicate number of plants.]

Country of origin.	Fruit stocks.							Rose stocks.
	Apple.	Plum.	Cherry.	Quince.	Pear.	Persimmon.	Unclassified.	
England.....								1,041,700
France.....	1,825,000	707,800	2,868,720	758,800	1,107,900		459,900	1,606,525
Holland.....	103,000			500	500			601,411
Ireland.....								115,000
Italy.....							300	
Japan.....						24,200		
Scotland.....								150,000
Total.....	1,928,000	707,800	2,868,720	759,300	1,108,400	24,200	460,200	3,514,636

#### BULBS.

[Figures indicate number of bulbs.]

Country of origin.	Lily.	Lily of the valley.	Narcissus.	Hyacinth.	Tulip.	Crocus.	Unclassified.
Azores.....	14,000						
Bermuda.....	115,189						
China.....			603,900				
England.....		800	669,356	7,000	12,500		
France.....	931,487		26,487,101		2,278,125		336,790
Germany.....		3,974,885	150,050				
Holland.....	128,929	5,989,162	28,076,321	16,368,494	47,681,559	3,977,892	1,317,000
Japan.....	13,349,331		46,190				
Total.....	14,538,936	9,964,847	56,032,918	16,375,494	49,972,184	3,977,892	1,653,790

*Country of origin and nature of importations under regulation 3, Quarantine 37—Continued.*

## SEEDS.

[Figures indicate pounds unless otherwise designated.]

Country of origin.	Coniferous tree.	Deciduous tree.	Fruit tree.	Palm.	Shrubs.	Perennials.	Unclassified.
Argentina.....				150			
Australia.....		19½		35,600			
Austria.....	1,030	350	800				425
Brazil.....				7,438			
Canada.....	5						
Denmark.....	95		25		7		
England.....				400			
France.....	11	13½	34,383	100	213	11½	388
Germany.....	1,770		300				
Holland.....					8	2	
Italy.....			900				
Japan.....	269½	6	434½		1	42½	11
New South Wales.....				3,000			
Norway.....	50						650
Trinidad.....				500			
Total.....	3,230½	389½	36,842½	47,188	229	44½	1,474

1 Ounces.

## IMPORTATION OF NURSERY STOCK AND OTHER PLANTS FOR PROPAGATION ONLY.

As already noted, provision is made in Quarantine 37 for the entry under special permit of limited quantities of otherwise prohibited nursery stock and other plants for the purpose of keeping the country supplied with new varieties and necessary propagating stock. The question of availability of plant material for which special permits are requested is passed upon by a committee of specialists of the Bureau of Plant Industry. The issuance of such permits is then based on the recommendations of this committee.

Three hundred and eleven special permits were issued during the period from June 1, 1919, the date on which Quarantine 37 became effective, to June 30, 1920, a period of 13 months. These permits included a wide range of plant materials and are each issued for a specific importation of plants. The importations authorized have already been made in the case of approximately 174 of these permits. The other permits have been canceled for a number of reasons, as a general rule because of the inability of the grower to secure the desired stock or because of transportation difficulties abroad and other similar hindrances.

The material thus imported was found as a whole fairly free from dangerous insects or fungus diseases. It was, however, necessary to destroy several shipments because of the presence of injurious insects which could not have been eliminated by any known treatment. In spite of the fact that emphasis has been made at all times on the necessity of bringing in plant material free of sand, soil, or earth about the roots, 12 shipments were found the roots of which in whole or in part were embedded in soil. These shipments were returned to country of origin or destroyed.

A large number of special permits have been issued also for the fiscal year ending June 30, 1921. The record of these permits is not included in the following tables, which give the classes of plants actually imported up to June 30, 1920, country of origin, and the States to which the imported plants were distributed. The actual



number of plants entered under each special permit is not given, but in most instances was not large.

*Country of origin and nature of importations of nursery stock under special permit June 1, 1919, to June 30, 1920.*

Country of origin.	Bulbs.	Herbaceous perennials.	Orchids.	Roses.	Deciduous shrubs.	Evergreen shrubs.	Florists' stock.	Coniferous.	Finished fruit trees.
Belgium.....						1			
Bermuda.....	2								
England.....	5	11	23	4			4		2
France.....	12	9		3	8	2	4	1	
Germany.....		1							
Holland.....	41	19		4	2	7		4	
Ireland.....		1		9					
Japan.....	1					5	2		1
Mexico.....	1								
Philippines.....			1						
Spain.....							1		
Trinidad.....							1		

NOTE.—Figures denote number of special permits under which importations were actually made. There is some duplication in these figures since a number of lots included material falling into two or more classes.

*Distribution by States of importation of nursery stock under special permit.*

Connecticut.....	1	New York.....	38
California.....	21	Ohio.....	11
District of Columbia.....	1	Oregon.....	1
Florida.....	3	Pennsylvania.....	18
Illinois.....	11	Rhode Island.....	1
Indiana.....	2	Tennessee.....	1
Massachusetts.....	17	Texas.....	2
Michigan.....	7	Virginia.....	3
Minnesota.....	1	Washington.....	6
Missouri.....	1	Wisconsin.....	1
New Hampshire.....	2		
New Jersey.....	25	Total.....	174

**INSPECTION OF IMPORTED PLANTS AND PLANT PRODUCTS.**

In spite of the reduction in the number of plants imported into the United States during the past fiscal year as the result of Quarantine 37, the total number of different kinds of insects (290 species) intercepted exceeds that of any previous fiscal year. This increase in the number of interceptions can probably be explained by the fact that all plants imported under special permit were examined under very favorable conditions by expert inspectors at Washington, D. C. Moreover, this material did not arrive in large quantities and it was possible to give each plant a very careful examination. Some of the more important interceptions follow: Gipsy moth egg masses on shipments of nursery stock from France; pink bollworm in shipments from China, Japan, and Mexico; potato tuber moth from Australia, Chile, Costa Rica, and Panama; the sorrel cutworm from France; spiny citrus white fly from Cuba; West Indian fruit fly from Jamaica and Cuba; injurious avocado weevils from Mexico, Guatemala, and the Canal Zone; apple-seed chalcis from Germany; wireworm, injurious to potatoes, from Denmark; sweet-potato weevil from Bahama, Cuba, and Porto Rico; West Indian sweet-potato weevil from Antigua and Porto Rico, and two other injurious sweet-potato weevils from Hawaii and Jamaica. Numerous other pests were collected, including scale insects, mites, and ants.

## INSPECTION OF PLANT-INTRODUCTION GARDENS.

As in former years, the board has continued to conduct inspections of the various plant-introduction gardens maintained by the Department of Agriculture at Yarrow, Md.; Miami and Brooksville, Fla.; Savannah, Ga.; and Chico, Calif., and the field station of the Office of Dry Land Agriculture, at Mandan, N. Dak.

## PORT INSPECTION SERVICE.

The inspection and disinfection of plants and plant products required as a condition of entry at the principal ports of the United States has been continued substantially along the lines described in previous reports. Numerous interceptions have been made at the port of New York, including a large shipment of Italian broom corn infested with the European corn borer. A careful inspection has been made of all foreign boats arriving at New Orleans, 1,608 in number, 289 of which carried contraband material either as cargo, ships' stores or in passengers' baggage. Exclusive of Canadian arrivals, 195 foreign ships were inspected at Seattle, 77 of which carried contraband material. The work at this port also included the supervision of cotton fumigation and corn sterilization.

In order to strengthen the plant-quarantine service of the State of California, the board has placed a trained pathological inspector at San Francisco to assist and cooperate with the State inspectors at that port. As in the past, the plant-quarantine inspectors of California as well as of the State of Florida are carried as collaborators of this board. In order to further safeguard against the entry into the United States of quarantined products or injurious insects and plant diseases inspectors have been placed at Portland, Oreg.; Philadelphia, Pa.; and Norfolk, Va. Moreover, it is proposed to study the conditions at other ports and if necessary establish an inspection service at the places presenting the most danger. It is understood that all port work is conducted in close cooperation with the customs officials.

The matter of strengthening the port-inspection service was brought strongly to the attention of Congress in connection with the estimates for the fiscal year ending June 30, 1921, and \$100,000 was included in the estimates for this purpose. Of this amount, \$76,756 was appropriated by Congress. The enlargement of the work under the plant-quarantine act leads to a constant growth in the requirements of this port-inspection service and the funds available are still very inadequate to give the service and protection which is necessary to secure the full benefits of the plant-quarantine act. Most of the increase granted last year will be taken up in strengthening the existing service and extensions of the service to the ports of greatest danger which it has not been possible hitherto to safeguard.

## NEW PLANT QUARANTINES.

The following foreign and domestic quarantines and other restrictive orders have been promulgated or revised during the year:

*Domestic.*—The European corn borer quarantine (a revision), the Japanese beetle quarantine (a revision), the gipsy moth and brown-tail moth quarantine (a revision), the pink bollworm quarantine, and the Hawaiian and Porto Rican cotton, cotton seed, and cottonseed products quarantine.

*Foreign.*—The flag smut and take-all quarantine, the Mexican corn quarantine, the European corn borer and other dangerous in-



sect pests and plant disease quarantine, and the stocks, cuttings, scions and buds of fruits quarantine.

The European corn borer, Japanese beetle, and the gipsy moth and browntail moth quarantines were revised to cover the additional territory invaded by these pests during the year.

The European corn-borer quarantine, which originally applied only to a restricted area in eastern Massachusetts, has been extended to include the States of New Hampshire, New York, and Pennsylvania.

In the case of the gipsy moth and brown-tail moth quarantine, the range of the gipsy moth was extended considerably, especially westward, owing to favorable winds. With respect to the brown-tail moth, however, it was found possible to materially reduce the territory quarantined on account of this pest. The heavy mortality of the pest in the brown-tail webs during the winter, the work of introduced parasites, direct field work against the insect, and the work of the brown-tail fungus were all contributing factors in the reduction of the area infested by the brown-tail moth.

#### AMENDMENT TO PLANT QUARANTINE ACT AUTHORIZING CONTROL OF PLANTS AND PLANT PRODUCTS FOR THE DISTRICT OF COLUMBIA.

The proposed amendment to the plant quarantine act, which was submitted to the last two Congresses, was approved by the last Congress in connection with the act making appropriations for this department for the fiscal year ending June 30, 1921. It has for its purpose the giving of authority to regulate the movement of plants and plant products, including nursery stock, from or into the District of Columbia, and to control injurious plant diseases and insect pests within said district. These powers are such as are exercised in practically all the States and territories of the United States and are necessary for the alignment of the District of Columbia with plant-pest control exercised elsewhere. Prior to the enactment of this amendment there was no law under which such control could be exercised in the District of Columbia. As a result at least one and perhaps other important fruit and plant pests have gained entry and spread into adjacent States through the District of Columbia.

In pursuance of the authority given by this amendment, rules and regulations governing such movement of plants and plant products into and out of the District of Columbia, effective on and after September 1, 1920, were promulgated by the Secretary of Agriculture August 26, 1920.

Under the authority of this act also terminal inspection of mail shipments of plants and plant products received in the District of Columbia has been established under the act of May 4, 1915, embodied in section 478½, Postal Laws and Regulations. The plants and plant products subject to terminal inspection in the District of Columbia are described as follows:

All florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plants and plant products in the raw or unmanufactured state, except vegetable and flower seeds.

#### CONVICTIONS FOR VIOLATIONS OF THE PLANT QUARANTINE ACT.

During the year reports were received from the Solicitor of the department of the conviction of two shippers for violations of the plant quarantine act, one in regard to the gipsy moth and brown-tail moth quarantine, and the other in regard to the white pine blister rust quarantine.



## LIST OF CURRENT QUARANTINE AND OTHER RESTRICTIVE ORDERS.

### QUARANTINE ORDERS.

The numbers assigned to these quarantines indicate merely the chronological order of issuance of both domestic and foreign quarantines in one numerical series. The quarantine numbers missing in this list are quarantines which have either been superseded or revoked. For convenience of reference these quarantines are here classified as domestic and foreign.

### DOMESTIC QUARANTINES.

*Date palms.*—Quarantine No. 6: Regulates the interstate movement of date palms or date-palm offshoots from Riverside County, Calif., east of the San Bernardino meridian; Imperial County, Calif.; Yuma, Maricopa, and Pinal Counties, Ariz.; and Webb County, Tex.; on account of the *Parlatoria* scale (*Parlatoria blanchardi*) and the *Phoenicococcus* scale (*Phoenicococcus marlatti*).

*Hawaiian fruits.*—Quarantine No. 13, revised: Prohibits or regulates the importation from Hawaii of all fruits and vegetables, in the natural or raw state, on account of the Mediterranean fruit fly and the melon fly.

*Sugar cane.*—Quarantine No. 16: Prohibits the importation from Hawaii and Porto Rico of living canes of sugar cane, or cuttings or parts thereof, on account of certain injurious insects and fungous diseases.

*Five-leaved pines, Ribes, and Grossularia.*—Quarantine No. 26, as amended: Prohibits the interstate movement of five-leaved pines, currant and gooseberry plants from all States east of and including the States of Minnesota, Iowa, Missouri, Arkansas, and Louisiana to points outside of this area; prohibits, further (1) the interstate movement of five-leaved pines and black-currant plants to points outside the area comprising the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and New York, and (2) to protect the State of New York, the movement from the New England States, on account of the white-pine blister rust.

*Sweet potato and yam.*—Quarantine No. 30: Prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State, or District of the United States of all varieties of sweet potatoes and yams (*Ipomoea batatas* and *Dioscorea* spp.), regardless of the use for which the same are intended, on account of the sweet-potato weevil (*Cylas formicarius*) and the sweet-potato scarabee (*Euscepes batatae*).

*Banana plants.*—Quarantine No. 32: Prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State, or District of the United States of any species or variety of banana plants (*Musa* spp.), regardless of the use for which the same are intended, on account of two injurious weevils, *Rhabdocnemis obscurus* and *Metamasius hemipterus*.

*Black stem rust.*—Quarantine No. 38: Prohibits the movement interstate to any point outside of the quarantined area of the common barberry and its horticultural varieties, as well as certain other species of *Berberis* and *Mahonia*, on account of the black stem rust of wheat, oats, barley, rye, and many wild and cultivated grasses.

*European corn borer.*—Quarantine No. 43 as amended: Regulates the movement interstate to any point outside of the quarantined area of corn and broom corn (including all parts of the stalk), celery, green beans in the pod, beets with tops, spinach, rhubarb, oat and rye straw as such or when used as packing, cut flowers or entire plants of chrysanthemum, aster, cosmos, zinnia, hollyhock, and cut flowers or entire plants of gladiolus and dahlia, except the bulbs thereof, without stems, on account of the European corn borer (*Pyrausta nubilalis*).

*Gipsy moth and brown-tail moth.*—Quarantine No. 45: Regulates the movement interstate to any point outside of the quarantined towns and territory, or from points in the generally infested area to points in the lightly infested area, of stone or quarry products, and of the plants and the plant products listed therein. The quarantine covers all the New England States.

*Pink bollworm.*—Quarantine No. 46: Prohibits the interstate movement from the infested and regulated areas of Texas and Louisiana of cotton, including all parts of the plant, seed cotton, cotton lint, linters, gin waste, and all other forms of cotton lint, cotton seed, cottonseed hulls, cottonseed cake and meal, bagging and other containers of the articles enumerated, and also railway cars, boats, and other vehicles which have been used in conveying cotton and cotton products grown in the infested districts or

which are fouled with such products, hay and other farm products, farm household goods, and farm equipment, except as provided in the rules and regulations supplemental thereto, on account of the pink bollworm of cotton (*Pectinophora gossypiella* Saunders).

*Hawaiian and Porto Rican cotton, cotton seed, and cottonseed products.*—Quarantine No. 47: Regulates the movement of cotton, cotton seed, and cottonseed products from Hawaii and Porto Rico on account of the pink bollworm and the cotton blister mite, respectively.

*Japanese beetle.*—Quarantine No. 48: Regulates the movement interstate to any point outside of certain portions of the Counties of Burlington and Camden, N. J., and certain portions of the Counties of Philadelphia and Bucks, Pa., of (1) farm, garden, and orchard products of all kinds; (2) grain and forage crops of all kinds; (3) nursery, ornamental, and greenhouse stock, and all other plants, including bulbs and cut flowers; and (4) soil, compost, and manure other than fresh manure, on account of the Japanese beetle (*Popillia japonica*).

#### FOREIGN QUARANTINES.

*Irish potatoes.*—Quarantine No. 3: Prohibits the importation of the common or Irish potato from Newfoundland; the islands of St. Pierre and Miquelon; Great Britain, including England, Scotland, Wales, and Ireland; Germany; and Austria-Hungary, on account of the disease known as potato wart.

*Mexican fruits.*—Quarantine No. 5, as amended: Prohibits the importation of oranges, sweet limes, grapefruit, mangoes, achras sapotes, peaches, guavas, and plums from the Republic of Mexico, on account of the Mexican fruit fly.

*Five-leaved pines, Ribes, and Grossularia.*—Quarantine No. 7, as amended: Prohibits the importation from each and every country of Europe and Asia, and from the Dominion of Canada and Newfoundland, of all five-leaved pines and all species and varieties of the genera *Ribes* and *Grossularia*, on account of the white-pine blister rust.

*Cotton seed and cottonseed hulls.*—Quarantine No. 8, as amended: Prohibits the importation from any foreign locality and country, excepting only the locality of the Imperial Valley, in the State of Lower California, Mexico, of cotton seed (including seed cotton) of all species and varieties, and cottonseed hulls, on account of the pink bollworm. Cotton and cotton seed from the Imperial Valley may be entered under permit and regulation.

*Seeds of avocado or alligator pear.*—Quarantine No. 12: Prohibits the importation from Mexico and the countries of Central America of the seeds of the avocado or alligator pear, on account of the avocado weevil.

*Sugar cane.*—Quarantine No. 15: Prohibits the importation from all foreign countries of living canes of sugar cane, or cuttings or parts thereof, on account of certain injurious insects and fungous diseases. There are no restrictions on the entry of such materials into Hawaii and Porto Rico.

*Citrus nursery stock.*—Quarantine No. 19: Prohibits the importation from all foreign localities and countries of all citrus nursery stock, including buds, scions, and seeds, on account of the citrus canker and other dangerous citrus diseases. The term "citrus" as used in this quarantine, includes all plants belonging to the subfamily or tribe *Citrateae*.

*European pines.*—Quarantine No. 20: Prohibits, on account of the European pine-shoot moth (*Evetria buoliana*), the importation from all European countries and localities of all pines not already excluded by Quarantine No. 7.

*Indian corn or maize and related plants.*—Quarantine No. 24, as amended: Prohibits the importation from southeastern Asia (including India, Siam, Indo-China, and China), Malayan Archipelago, Australia, New Zealand, Oceania, Philippine Islands, Formosa, Japan, and adjacent islands, in the raw or unmanufactured state, of seed and all other portions of Indian corn or maize (*Zea mays* L.), and the closely related plants, including all species of Teosinte (*Euchlaena*), Job's tears (*Coix*), *Polytoca*, *Chionachne*, and *Sclerachne*, on account of the downy mildews and *Physoderma* diseases of Indian corn, except that Indian corn or maize may be imported under permit and upon compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

*Citrus fruit.*—Quarantine No. 28: Prohibits the importation from eastern and southeastern Asia (including India, Siam, Indo-China, and China), the Malayan Archipelago, the Philippine Islands, Oceania (except Australia, Tasmania, and New Zealand), Japan (including Formosa and other islands adjacent to Japan), and the Union of South Africa, of all species and varieties of citrus fruits, on account of the citrus canker, except that oranges of the mandarin class (including satsuma and tangerine varieties) may be imported under permit and upon compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.



*Sweet potato and yam.*—Quarantine No. 29: Prohibits the importation for any purpose of any variety of sweet potatoes or yams (*Ipomoea batatas* and *Dioscorea* spp.) from all foreign countries and localities, on account of the sweet potato weevils (*Cylas* spp.) and the sweet potato scarabee (*Euscepes batatae*).

*Banana plants.*—Quarantine No. 31: Prohibits the importation for any purpose of any species or variety of banana plants (*Musa* spp.), or portions thereof, from all foreign countries and localities, on account of the banana root borer (*Cosmopolites sordidus*).

*Bamboo.*—Quarantine No. 34: Prohibits the importation for any purpose of any variety of bamboo seed, plants, or cuttings thereof capable of propagation, including all genera and species of the tribe *Bambuseae*, from all foreign countries and localities, on account of dangerous plant diseases, including the bamboo smut (*Ustilago shiraiana*). This quarantine order does not apply to bamboo timber consisting of the mature dried culms or canes which are imported for fishing rods, furniture making, or other purposes, or to any kind of article manufactured from bamboo, or to bamboo shoots cooked or otherwise preserved.

*Nursery stock, plants, and seeds.*—Quarantine No. 37, as amended, with regulations (effective on and after June 1, 1919): Prohibits the importation of nursery stock and other plants and seeds from all foreign countries and localities, on account of certain injurious insects and fungous diseases, except as provided in the regulations. Under this quarantine the following plants and plant products may be imported without restriction: Fruits, vegetables, cereals, and other plant products imported for medicinal, food, or manufacturing purposes, and field, vegetable, and flower seeds. The entry of the following plants is permitted under permit: Lily bulbs, lily of the valley, narcissus, hyacinths, tulips, and crocus; stocks, cuttings, scions, and buds of fruits; rose stocks, including manetti, multiflora, briar rose, and rosa rugosa; nuts, including palm seeds; seeds of fruit, forest, ornamental, and shade trees; seeds of deciduous and evergreen ornamental shrubs, and seeds of hardy perennial plants.

Provision is also made for the issuance of special permits under safeguards to be prescribed in such permits for the entry in limited quantities of nursery stock and other plants and seeds not covered in the preceding lists for the purpose of keeping the country supplied with new varieties and necessary propagating stock.

*Flag smut and take-all.*—Quarantine No. 39, with regulations (effective on and after August 15, 1919): Prohibits the importation of seed or paddy rice from Australia, India, Japan, Italy, France, Germany, Belgium, Great Britain, Ireland, and Brazil on account of two dangerous plant diseases known as flag smut (*Urocystis tritici*) and take-all (*Ophiobolus graminis*). Wheat, oats, barley, and rye may be imported from the countries named only under permit and upon compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

*European corn borer.*—Quarantine No. 41, as amended, with regulations: Prohibits the importation of the stalk and all other parts, whether used for packing or other purposes, in the raw or unmanufactured state, of Indian corn or maize, broom corn, sweet sorghums, grain sorghums, Sudan grass, Johnson grass, sugar cane, pearl millet, napier grass, teosinte and Job's tears, from all foreign countries and localities, except as provided in the rules and regulations supplemental thereto, on account of the European corn borer (*Pyrausta nubilalis*) and other dangerous insects and plant diseases.

*Mexican corn.*—Quarantine No. 42, with regulations: Prohibits the importation of Indian corn or maize from Mexico, except as provided in the rules and regulations supplemental thereto, on account of the contamination of such corn with cotton seed more or less infested with the pink bollworm.

*Stocks, cuttings, scions, and buds of fruits.*—Quarantine No. 44: Prohibits the importation of stocks, cuttings, scions, and buds of fruits from Asia, Japan, Philippine Islands, and Oceania (including Australia and New Zealand) on account of dangerous plant diseases, including Japanese apple cankers, blister blight, and rusts, and injurious insect pests, including the oriental fruit moth, the pear fruit borer, the apple moth, etc.

#### OTHER RESTRICTIVE ORDERS.

The regulation of the entry of nursery stock from foreign countries into the United States was specifically provided for in the plant-quarantine act. The act further provides for the similar regulation of any other class of plants or plant products when the need thereof shall be determined. The entry of the plants and plant products listed below has been brought under such regulation:

*Nursery stock.*—The conditions governing the entry of nursery stock and other plants and seeds from all foreign countries and localities are indicated above under "Foreign Quarantines." (See Quarantine No. 37.)



*Irish potatoes.*—The importation of Irish potatoes is prohibited from the countries enumerated in the potato quarantine. Potatoes may be admitted from other foreign countries under permit and in accordance with the provisions of the regulations issued under the order of December 22, 1913, bringing the entry of potatoes under restriction on account of injurious potato diseases and insect pests. Importation of potatoes is now authorized from the following countries: Denmark, Cuba, Bermuda, and the Dominion of Canada. The regulations issued under this order have been amended so as to permit, free of any restrictions whatsoever under the plant-quarantine act, the importation of potatoes from any foreign country into the Territories of Porto Rico and Hawaii for local use only and from the Dominion of Canada and Bermuda into the United States or any of its Territories or Districts.

*Avocado, or alligator pear.*—The order of February 27, 1914, prohibits the importation from Mexico and the countries of Central America of the fruits of the avocado, or alligator pear, except under permit and in accordance with the other provisions of the regulations issued under said order on account of the avocado weevil. Entry is permitted through the port of New York only and is limited to the large, thick-skinned variety of the avocado. The importation of the small, purple, thin-skinned variety of the fruit of the avocado and of avocado nursery stock under 18 months of age is prohibited.

*Cotton.*—The order of April 27, 1915, prohibits the importation of cotton from all foreign countries and localities, except under permit and in accordance with the other provisions of the regulations issued under said order, on account of injurious insects, including the pink bollworm. These regulations apply in part to cotton grown in and imported from the Imperial Valley, in the State of Lower California, in Mexico.

*Corn.*—The order of March 1, 1917 (Amendment No. 1, with Regulations, to Notice of Quarantine No. 24), prohibits the importation of Indian corn or maize in the raw or unmanufactured state from the countries and localities listed in Notice of Quarantine No. 24, except under permit and in accordance with the other provisions of the regulations issued under said order, on account of injurious diseases of Indian corn.

*Cottonseed products.*—The order of June 23, 1917, prohibits the importation of cottonseed cake, meal, and all other cottonseed products, except oil, from all foreign countries, and a second order of June 23, 1917, prohibits the importation of cottonseed oil from Mexico, except under permit and in accordance with the other provisions of the regulations issued under said orders, on account of injurious insects, including the pink bollworm.

*Citrus fruits.*—The order of June 27, 1917 (Notice of Quarantine No. 28, with Regulations), prohibits the importation from the countries and localities listed therein of all species and varieties of citrus fruits, excepting only oranges of the mandarin class (including satsuma and tangerine varieties), on account of the citrus-canker disease. Oranges of the mandarin class (including satsuma and tangerine varieties) may be imported under permit and in accordance with the other provisions of the regulations issued under said order.

*Indian corn, broom corn, and related plants.*—The order of February 21, 1920 (Notice of Quarantine No. 41, with Regulations), prohibits the importation in the raw or unmanufactured state of the stalk and all other parts of Indian corn or maize, broom corn, sweet sorghums, grain sorghums, Sudan grass, Johnson grass, sugar cane, including Japanese varieties, pearl millet, napier grass, teosinte, and Job's tears from all foreign countries and localities on account of the European corn borer and other dangerous insects and plant diseases. The regulations issued under said order permit the importation without restriction of sorghum hay from Canada and clean shelled or threshed grain, from any country, of the plants covered by this order. Provision is also made for the importation of broom corn under permit and in accordance with the other provisions of the regulations for manufacturing purposes.

*Mexican corn.*—The order of February 21, 1920 (Notice of Quarantine No. 42, with Regulations), prohibits the importation of Indian corn or maize from Mexico, except under permit and in accordance with the other provisions of the regulations issued under said order, on account of contamination of such corn with cotton seed more or less infested with the pink bollworm.

*Stocks, cuttings, scions, and buds of fruits.*—The order of March 24, 1920 (Notice of Quarantine No. 44), prohibits the importation of stocks, cuttings, scions, and buds of fruits for or capable of propagation from Asia, Japan, Philippine Islands, and Oceania (including Australia and New Zealand) on account of certain dangerous plant diseases and injurious insect pests. Provision is made for the importation under special permits issued by the Secretary of Agriculture of limited quantities of stocks, cuttings, scions, and buds of fruits from the countries and localities named for the purpose of keeping the country supplied with new varieties and necessary propagating stock.

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